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# Comparison of the Seismic Provisions of Model Building Codes and Standards to the 1994 NEHRP Recommended Provisions

Building and Fire Research Laboratory
Gaithersburg, MD 20899

NIST

United States Department of Commerce
Technology Administration
National Institute of Standards and Technology

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Degenkolb Engineers
San Francisco, California

A report to:

Building and Fire Research Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899

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**U. S. Department of Commerce**
William M. Daley, *Secretary*
Technology Administration
Gary Bachula, *Acting Under Secretary for Technology*
National Institute of Standards and Technology
Raymond G. Kammer, *Director*

# ACKNOWLEDGEMENT

Project participants — Degenkolb Engineers:

Chris D. Poland

Jon A. Heintz

Darrick Hom

Laurie Iida

Leader — Earthquake Engineering Group (NIST):

Riley Chung

# TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY ..... 1

2.0 INTRODUCTION ..... 3

3.0 1994 NEHRP PROVISIONS ..... 5

3.1 OVERVIEW OF NEHRP PROVISIONS ..... 5

3.2 OVERVIEW OF CHANGES BETWEEN 1991 AND 1994 ..... 5

3.2.1 Chapter 1: General Provisions (Testing & Inspection) ..... 6

3.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads) ..... 6

3.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements ..... 7

3.2.4 Chapter 4: Foundation Design Requirements ..... 7

3.2.5 Chapter 5: Steel Structure Design Requirements ..... 7

3.2.6 Chapter 6: Concrete Structure Design Requirements ..... 7

3.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements ..... 8

3.2.8 Chapter 8: Masonry Structure Design Requirements ..... 8

3.2.9 Chapter 9: Wood Structure Design Requirements ..... 8

4.0 COMPARISON OF 1996 BOCA TO 1994 NEHRP ..... 10

4.1 OVERVIEW OF BOCA PROVISIONS ..... 10

4.2 COMPARISON OF BOCA TO NEHRP ..... 11

4.2.1 Chapter 1: General Provisions (Testing & Inspection) ..... 11

4.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads) ..... 11

4.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements ..... 11

4.2.4 Chapter 4: Foundation Design Requirements ..... 11

4.2.5 Chapter 5: Steel Structure Design Requirements ..... 11

4.2.6 Chapter 6: Concrete Structure Design Requirements ..... 12

4.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements ..... 12

4.2.8 Chapter 8: Masonry Structure Design Requirements ..... 12

4.2.9 Chapter 9: Wood Structure Design Requirements ..... 12

4.3 CONCLUSIONS REGARDING BOCA ..... 13

5.0 COMPARISON OF 1997 UBC TO 1994 NEHRP ..... 14
5.1 OVERVIEW OF UBC PROVISIONS ..... 14
5.2 COMPARISON OF UBC TO NEHRP ..... 15
5.2.1 Chapter 1: General Provisions (and Testing & Inspection) ..... 15
5.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads) ..... 16
5.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements ..... 17
5.2.4 Chapter 4: Foundation Design Requirements ..... 17
5.2.5 Chapter 5: Steel Structure Design Requirements ..... 18
5.2.6 Chapter 6: Concrete Structure Design Requirements ..... 18
5.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements ..... 19
5.2.8 Chapter 8: Masonry Structure Design Requirements ..... 19
5.2.9 Chapter 9: Wood Structure Design Requirements ..... 19
5.3 CONCLUSIONS REGARDING UBC ..... 20

6.0 COMPARISON OF 1997 SBC TO 1994 NEHRP ..... 21
6.1 OVERVIEW OF SBC PROVISIONS ..... 21
6.2 COMPARISON OF SBC TO NEHRP ..... 22
6.2.1 Chapter 1: General Provisions (Testing & Inspection) ..... 22
6.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads) ..... 22
6.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements ..... 22
6.2.4 Chapter 4: Foundation Design Requirements ..... 22
6.2.5 Chapter 5: Steel Structure Design Requirements ..... 23
6.2.6 Chapter 6: Concrete Structure Design Requirements ..... 23
6.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements ..... 23
6.2.8 Chapter 8: Masonry Structure Design Requirements ..... 23
6.2.9 Chapter 9: Wood Structure Design Requirements ..... 24
6.3 CONCLUSIONS REGARDING SBC ..... 24

7.0 COMPARISON OF ASCE 7-95 TO 1994 NEHRP ..... 25
7.1 OVERVIEW OF ASCE 7 PROVISIONS ..... 25
7.2 COMPARISON OF ASCE 7 TO NEHRP ..... 26
7.2.1 Chapter 1: General Provisions (and Testing & Inspection) ..... 26
7.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads) ..... 26
7.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements ..... 27
7.2.4 Chapter 4: Foundation Design Requirements ..... 27
7.2.5 Chapter 5: Steel Structure Design Requirements ..... 27
7.2.6 Chapter 6: Concrete Structure Design Requirements ..... 27
7.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements ..... 28
7.2.8 Chapter 8: Masonry Structure Design Requirements ..... 28
7.2.9 Chapter 9: Wood Structure Design Requirements ..... 28
7.3 CONCLUSIONS REGARDING ASCE 7 ..... 29

8.0 COMPARISON OF 1995 OTFDC TO 1994 NEHRP ..... 30
8.1 OVERVIEW OF OTFDC PROVISIONS ..... 30
8.2 COMPARISON OF OTFDC TO NEHRP ..... 31
8.2.1 Chapter 1: General Provisions (and Testing & Inspection) ..... 31
8.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads) ..... 32
8.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements ..... 32
8.2.4 Chapter 4: Foundation Design Requirements ..... 32
8.2.5 Chapter 5: Steel Structure Design Requirements ..... 33
8.2.6 Chapter 6: Concrete Structure Design Requirements ..... 33
8.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements ..... 33
8.2.8 Chapter 8: Masonry Structure Design Requirements ..... 33
8.2.9 Chapter 9: Wood Structure Design Requirements ..... 34
8.3 CONCLUSIONS REGARDING OTFDC ..... 34

9.0 CONCLUSIONS ..... 35

REFERENCES ..... 36

**Detailed Comparison Tables**

Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent..... 37
Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent ..... 53
Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent ..... 70
Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent ..... 86
Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent ..... 108
Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent..... 124
Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent.... 138
Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent ..... 150
Table 5A: Changed Provisions in OTFDC and NEHRP Judged Not Equivalent.... 167
Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant..... 173

# 1.0 EXECUTIVE SUMMARY

Executive Order 12699, *Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction*, requires that all federally owned, leased, assisted, and regulated buildings be designed and constructed in accordance with appropriate seismic standards. The Interagency Committee on Seismic Safety in Construction (ICSSC) has recommended the use of building codes which are substantially equivalent to the *National Earthquake Hazard Reduction Program Recommended Provisions for the Development of Seismic Regulations for New Buildings* (NEHRP Provisions).

The National Institute of Standards and Technology has commissioned a comparison between the NEHRP Provisions and selected model building codes and standards. The objective of this study is to determine whether or not the seismic and material design provisions of the latest model building codes and standards are substantially equivalent to, or exceed, the 1994 NEHRP Provisions. The model codes and standards under consideration are the 1996 BOCA *National Building Code* (BOCA), 1997 ICBO *Uniform Building Code* (UBC), 1997 SBCCI *Standard Building Code* (SBC), ASCE 7-95 *Minimum Design Loads for Buildings and Other Structures* (ASCE 7), and 1995 CABO *One and Two Family Dwelling Code* (OTFDC).

This report builds on the conclusions of two previous reports prepared for National Institute of Standards and Technology (NIST 95674 and NIST 91598). These previous comparison reports have concluded that previous editions of these model codes and standards were substantially equivalent to NEHRP. In building on the conclusion of past equivalence, it is only necessary to compare and evaluate changes that have occurred between the previous editions and the most recent editions of the model codes and standards in question. This report summarizes and documents changes in each model code or standard since the date of the last comparison report. It then compares the current version of each document to the 1994 NEHRP Provisions and renders a judgment regarding equivalence. It contains a discussion providing an overview of the comparison results and concludes with a series of tables providing a detailed side-by-side comparison of changed provisions.

In the past BOCA has adopted the NEHRP Provisions directly without many modifications. However, the 1996 BOCA did not incorporate many of the changes that were made to the 1994 NEHRP Provisions. Therefore, the documents were found to be equivalent in intent but not equivalent in design values. The conclusion of the comparison is that NEHRP will provide a higher level of safety than the 1996 BOCA Code because of differences in design values and the documents are judged not equivalent.

The 1997 UBC was substantially revised to utilize a strength based design approach. The seismic design basis change in UBC allowed a more direct comparison of the two documents. They were found to be equivalent in intent and essentially equivalent in design values with some exceptions. These exceptions are documented in the sections that follow.

In the past SBCCI has adopted the NEHRP Provisions directly without many modifications. However, the 1997 SBC did not incorporate many of the changes that were made to the 1994 NEHRP Provisions. Therefore, the documents were found to be equivalent in intent but not equivalent in design values. The conclusion of the comparison is that NEHRP will provide a higher level of safety than the 1997 SBC Code because of differences in design values and the documents are judged not equivalent.

For the determination of loads ASCE 7 has developed its own guidelines. For all other aspects of the standard, ASCE 7 incorporates the 1994 NEHRP Provisions, with some revisions. The documents were found to be equivalent in intent and equivalent in design values with some exceptions. These exceptions are documented in the sections that follow.

The scope of OTFDC is limited to wood frame residential construction, which represents a small fraction of what is addressed in the NEHRP Provisions. Because of this, the comparison has been limited to only those issues common to both OTFDC and NEHRP. Since NEHRP references OTFDC for conventional construction provisions, the documents are judged equivalent in that regard. For engineered construction, OTFDC has only minimal provisions on earthquake-resistant design and the documents are judged not equivalent in that regard. The conclusion of the comparison is that OTFDC and 1994 NEHRP Provisions are judged equivalent when conventional construction provisions are applicable, and are judged not equivalent when an engineered design is required.

# 2.0 INTRODUCTION

Executive Order 12699, *Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction*, requires that all federally owned, leased, assisted, and regulated buildings be designed and constructed in accordance with appropriate seismic standards. The Interagency Committee on Seismic Safety in Construction (ICSSC) has recommended the use of building codes which are substantially equivalent to the *National Earthquake Hazard Reduction Program Recommended Provisions for the Development of Seismic Regulations for New Buildings* (NEHRP Provisions).

The National Institute of Standards and Technology has commissioned a comparison between the NEHRP Provisions and selected model building codes and standards. The objective of this study is to determine whether or not the seismic and material design provisions of the latest model building codes and standards are substantially equivalent to, or exceed, the 1994 NEHRP Provisions. The model codes and standards under consideration are the 1996 BOCA *National Building Code* (BOCA), 1997 ICBO *Uniform Building Code* (UBC), 1997 SBCCI *Standard Building Code* (SBC), ASCE 7-95 *Minimum Design Loads for Buildings and Other Structures* (ASCE 7) and 1995 CABO *One and Two Family Dwelling Code* (OTFDC).

This report builds on the conclusions of two previous reports prepared for National Institute of Standards and Technology (NIST 95674 and NIST 91598). These previous comparison reports have concluded that previous editions of these model codes and standards were substantially equivalent to NEHRP. In building on the conclusion of past equivalence, it is only necessary to compare and evaluate changes that have occurred between the previous editions and the most recent editions of the model codes and standards in question. This report summarizes and documents changes in each model code or standard since the date of the last comparison report. It then compares the current version of each document to the 1994 NEHRP Provisions and renders a judgment regarding equivalence. It contains a discussion providing an overview of the comparison results and concludes with a series of tables providing a detailed side-by-side comparison of changed provisions.

Two versions of the NEHRP Provisions and each model code and standard are reviewed and documented. These include the 1991 and 1994 NEHRP Provisions, 1993 and 1996 BOCA, 1994 and 1997 UBC, 1994 and 1997 SBC, ASCE 7-93 and ASCE 7-95, and 1992 and 1995 OTFDC. Comparisons are made on the basis of seismic provisions, material design provisions, foundation design requirements, quality assurance provisions, and non-structural element design requirements. Following a review of the relevant sections of both the previous edition and the current edition of each code and standard, changes between editions are documented, the impact of the changes are evaluated, and comparisons are made to the 1994 NEHRP Provisions. In the comparison, the documents are judged equivalent if the model code or standard provisions are equivalent to, or more stringent than, the requirements in NEHRP. The documents are judged not equivalent if the provisions in NEHRP are more stringent than the requirements in the model building code or standard. In comparing the documents, only changes that were judged to be substantive were documented.

In certain instances NEHRP includes provisions that the model codes or standards do not. When the model codes or standards do not have specific provisions regarding criteria, elements or systems, the design is left to the discretion of the designer. Depending on the judgment of the designer, the design may or may not be equivalent to NEHRP. Therefore, when the model code or standard is silent on certain issues, equivalence may not be judged. In the case of OTFDC, since the scope is limited to wood frame residential construction, the comparison is limited to only those provisions which are present in both NEHRP and OTFDC. NEHRP Provisions that are beyond the scope of OTFDC are judged not relevant to the comparison.

What follows is a general discussion of the 1994 NEHRP Provisions and the changes that have been made since 1991, followed by a general discussion of the comparison between the major changes in NEHRP and the model codes and standards. Each comparison is a stand-alone section. Detailed side by side comparisons are included in tables following the discussion. The tables form the basis of the conclusions regarding equivalence, and are intended to be used when more detailed information is of interest. The tables are arranged according to NEHRP section numbers, and changed provisions judged not equivalent have been grouped together in separate tables from those judged equivalent for easier comparison.

# 3.0 1994 NEHRP PROVISIONS

## 3.1 Overview of NEHRP Provisions

The Federal Emergency Management Agency (FEMA) has contracted the Building Seismic Safety Council (BSSC) to develop the National Hazards Reduction Program (NEHRP) Provisions for new buildings. One of the primary goals of the program is to reduce or mitigate losses from earthquakes. The NEHRP Recommended Provisions for Seismic Regulations for New Buildings are recommended provisions that are sometimes adopted by codes and local governments. The 1994 edition of the NEHRP Provisions is the third update of the document. The NEHRP Provisions will be the basis for the 2000 International Building Code.

The NEHRP Provisions outline a strength-based approach to design that represents the state of knowledge in seismic design. The seismic design provisions incorporate current research and knowledge from previous earthquakes. Seismicity maps are used to assess the seismic hazard of a particular region. Forces and seismic design requirements are increased with increased seismic hazard. The seismic performance category (SPC) of a structure, which is based on occupancy as well as the seismicity, determines the level of detailing and design requirements. The seismic performance category is used to obtain higher levels of performance, however, it does not influence the force level. In the base shear equation, a factor (R) which accounts for system response and ductility, reduces the ground motion to a design level. The design base shear varies with $1/T^{2/3}$, where T is the period of the structure.

## 3.2 Overview of Changes Between 1991 and 1994

The document is organized in code format. The organizational structure of the NEHRP Provisions was completely revised in the 1994 edition. Changes made with respect to formatting are not documented in this report. Chapters 1 through 9 and Appendix A of the 1994 editions, and the corresponding chapters in the 1991 edition are reviewed. Appendix A documents the differences between the 1994 and 1991 editions of the provisions. The side by side comparison tables provide more detailed documentation of the NEHRP changes. Only changes that were judged to be substantial are included in the tables. Provisions that are judged not equivalent to the model codes and standards are located in a separate table than provisions that are judged equivalent.

Major changes to the provisions are as follows:

### 3.2.1 Chapter 1: General Provisions (Testing & Inspection)

Soil profile types were redefined and expanded. Unlike the previous 4 soil types, the 6 new types are based quantitatively on shear wave velocity. Recorded data and analytical studies of ground motion propagation through soil are the basis of the use of shear wave velocity as an appropriate measure of soil amplification characteristics. There is no direct correlation between the previous and new soil types, and the change in types will yield different seismic coefficient values.

New seismic coefficients were introduced to replace previous coefficients. In general, the change produces more stringent loads and requirements for structures on soft soils and less stringent loads and requirements for structures on hard rock. The change affects all provisions that refer to the coefficients.

The special inspection requirements were modified. Some of the changes made the requirements more stringent and some made them less. The requirement for continuous special inspection for the placement of concrete in foundations was added. The requirement for continuous special inspection for construction of drilled piles and caissons was changed to periodic inspection. The requirement for periodic inspection of placement of reinforcing steel in foundations, and during and upon completion of reinforcing steel placement in intermediate concrete moment frames and concrete shear walls was added. The requirement for periodic special inspection of placement of steel in reinforced masonry shear walls and ordinary moment frames and during placement of concrete in reinforced concrete frames and shear walls was deleted. The requirement for special inspection during and on completion of the placement of concrete for intermediate and special moment frames and boundary members of concrete shear walls, and after the completion of placement of prestressing steel was added.

### 3.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads)

The base shear equation was revised to incorporate the new soil profile types and seismic coefficients described in Chapter 1.

Composite systems were added to the list of building systems. Response values are included for the new composite systems.

The load combinations now reference ASCE 7-93. In earthquake load combinations, the dead load factor is slightly higher but the live and snow load factors are typically lower. The vertical earthquake loads depend on $C_a$ where they previously depended on $A_v$. The new vertical loads will be less for soil profile A, equivalent for soil type B and in most cases larger for soil types C, D and E.

New sections were added that include provisions for seismically isolated and nonbuilding structures. An appendix was added to introduce passive energy dissipation systems.

### 3.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements

The formulas to calculate the loads on architectural, mechanical and electrical systems were incorporated into general formulas applicable to all equipment. The loads are now dependent on a system amplification, ductility and importance factor. To match the measured response in buildings in recent earthquakes, the loads that result from the new equations are generally higher.

New requirements for bracing of nonstructural items such as access floors and suspended ceilings were added. The weight to be used in the force calculations, bracing and clearance requirements are among the new provisions that have been included in this section.

### 3.2.4 Chapter 4: Foundation Design Requirements

Because of changes to seismic coefficients, the design loads for ties between individual pile caps, drilled piers, or caissons were revised. The design loads that were previously a function of $A_v$ are now a function of $C_a$. With this change, the design forces are lower for hard rock and higher for soft soils.

Individual spread footings are now required to have ties in soft soil only. Previously, ties were required for conditions when the soil was anything other than rock.

### 3.2.5 Chapter 5: Steel Structure Design Requirements

*Seismic Provisions for Structural Steel Buildings* was added as a reference. Provisions duplicating this information were removed and the length of the section was reduced.

### 3.2.6 Chapter 6: Concrete Structure Design Requirements

Requirements for precast concrete elements and connections were added. Currently, if a precast element emulates the behavior of monolithic reinforced concrete, it may be included in the seismic force resisting system. The required yielding location and strength of the connection relative to the frame have been specified.

Additional requirements for diaphragms and coupling beams were added. The minimum required thickness of a cast-in-place concrete diaphragm must now be at least 2 inches thick. The minimum thickness of a cast-in-place reinforced topping slab bonded to a precast diaphragm must now be at least 2-1/2 inches thick, and the connections and bonding must be in accordance with specified provisions.

A provision which states that anchors shall be detailed so that the connection failure is initiated by the failure of the anchor steel rather than the failure of the surrounding concrete was added. The formula to calculate the strength in tension governed by concrete failure was revised and the resulting capacity is less. The interaction equations to check the capacity for a combination of tension and shear were revised and are now less stringent.

There are new limitations in the application of plain concrete. For structures in seismic performance category C, the application of plain concrete elements has new restrictions. Plain concrete is no longer permitted in buildings assigned to seismic performance category D or E, with some exceptions.

### 3.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements

This new chapter covers the design requirements for composite systems and elements. For the most part the user is directed to references in the concrete and steel chapters, however, there are additional requirements that are specific to composite systems and elements. Ties spacing and minimum tube thickness are among the additional requirements that have been given.

### 3.2.8 Chapter 8: Masonry Structure Design Requirements

The masonry chapter was revised to strength based design. Allowable stress design provisions were moved to the appendix and ultimate strength design provisions were moved from the appendix into the main body of the provisions. Various provisions such as the bundling of bars, reinforcement development formulas and the formula to calculate the shear strength of masonry were revised in this chapter.

### 3.2.9 Chapter 9: Wood Structure Design Requirements

Using factors, NEHRP revises allowable stress design to strength design. The factor used to increase the allowable working stress values to ultimate strength values was increased from 2.0 to 2.16. Additionally, several phi factors were reduced. In general, the combination provides a lower nominal capacity than the previous provisions.

The criteria for the application of conventional construction provisions was revised. Some of the limits are more stringent and some are less. The height of the building is no longer a factor in determining the limits of conventional construction. The required spacing between braced walls has been increased for seismic performance categories A and B. Previously all SPC A buildings could use conventional construction, now there are limitations. Previously the maximum number of stories permitted for conventional construction of SPC C building was 1 and now it is 2. Previously SPC D buildings could not utilize conventional construction in seismic hazard exposure groups II and III, and now conventional construction may be used for 1 story buildings with a maximum distance between braced walls of 25 feet.

In engineered construction, NEHRP no longer allows materials other than structural use materials to be part of the seismic force resisting system. This precludes the use of gypsum board and stucco on shear walls in all buildings other than conventional construction.

# 4.0 COMPARISON OF 1996 BOCA TO 1994 NEHRP

Previous reports concluded that the 1993 BOCA and the 1991 NEHRP Provisions were substantially equivalent. Since that time, changes have occurred in both documents which may or may not be equivalent. This section summarizes the changes and makes a comparison between the current versions of both documents. Further documentation of changes and detailed side-by-side comparisons are contained in Tables 1A and 1B.

## 4.1 Overview of BOCA Provisions

The Building Officials and Code Administrators (BOCA) assembles the *BOCA National Building Code* and has included some form of seismic design provisions since its inception in 1950. The stated intent of the code is to provide minimum standards to insure the public safety, health and welfare. Since 1992, BOCA has incorporated the NEHRP Provisions for seismic design. Thus, the methodology of the code is the same as NEHRP. It uses a strength-based approach, the same seismicity maps, the same seismic performance categories, the same R values, and the seismic forces vary with the inverse of $T^{2/3}$.

The changes between the 1993 and 1996 editions of BOCA are summarized below. Chapters 16 through 19, and 21 through 23 in the 1996 code are included in this comparison.

Few changes were made to formulas calculating seismic forces for structural, architectural, mechanical and electrical components. These sections have remained essentially the same from the 1993 to the 1996 edition.

Provisions regarding soil testing, foundation walls, and retaining walls, were rewritten and expanded such that they form individual sections rather than portions of the seismic design provisions.

The materials sections changed to the extent that BOCA has adopted the most current standards with few modifications. BOCA refers to AISC for steel, ACI for concrete and masonry, and AFPA for wood. BOCA, however, included new restrictions on the use of particleboard in subflooring and roof sheathing in the wood section.

Comparisons between the substantial changes in each document are summarized in the following section. The comparisons are arranged according to 1994 NEHRP chapters. For a more detailed and inclusive comparison, see Tables 1A and 1B.

## 4.2 Comparison of BOCA to NEHRP

### 4.2.1 Chapter 1: General Provisions (Testing & Inspection)

BOCA did not adopt the changes to the soil factors and seismic performance categories introduced in NEHRP. The $C_a$ and $C_v$ factors included in NEHRP result in higher calculated seismic forces for soil profiles C, D, and E, especially in regions of low seismicity. Although the new factors result in slightly lower forces for soil profile A and equal forces in soil profile B, the documents are judged not equivalent with regard to soil factors.

BOCA has similar, or more stringent, requirements regarding testing and inspection. Thus, the documents are judged equivalent with regard to inspection.

### 4.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads)

For calculation of seismic forces for structural components, BOCA did not adopt the changes introduced in NEHRP. The $C_a$ and $C_v$ factors included in NEHRP result in higher calculated seismic forces for very soft soils, especially in regions of low seismicity. Thus, NEHRP is more stringent than BOCA and these sections are not equivalent.

### 4.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements

For calculation of seismic forces for architectural, mechanical, and electrical components, BOCA did not adopt the changes introduced in NEHRP. The new formulas result in higher forces for nonstructural components. Thus, NEHRP is more stringent than BOCA and these sections are not equivalent.

### 4.2.4 Chapter 4: Foundation Design Requirements

Foundation design requirements in BOCA have been expanded, providing additional design requirements such as footing design, piles, and foundation and retaining walls. Thus, BOCA is more stringent than NEHRP and these sections are judged equivalent.

### 4.2.5 Chapter 5: Steel Structure Design Requirements

Both documents reference the same AISC standards without significant modification. Changes made to NEHRP either already existed in BOCA or were also changed in BOCA. Since both documents reference the same standard, BOCA and NEHRP are equivalent with regard to steel structure design requirements.

### 4.2.6 Chapter 6: Concrete Structure Design Requirements

Both documents adopt ACI 318, however, BOCA did not adopt NEHRP modifications to ACI dealing with requirements for precast concrete frames. In addition, BOCA did not adopt NEHRP changes regarding strength and failure of anchors. Thus, the documents are judged equivalent with regard to concrete structure design requirements except for precast concrete frame systems and strength and failure of anchors.

### 4.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements

There are no provisions in BOCA regarding the design of composite lateral force resisting systems. While BOCA does not prohibit composite design explicitly, it is silent on an approach to take to design a structure with a composite lateral-force-resisting system. Thus, NEHRP is more stringent with this type of structure and these documents are judged not equivalent with regard to structures with composite lateral force resisting systems.

### 4.2.8 Chapter 8: Masonry Structure Design Requirements

Regarding design of masonry structures, NEHRP has developed its own strength design guidelines while BOCA has adopted ACI 530. ACI 530, however, uses working stress design provisions and modifies them to fit strength design guidelines. In comparing NEHRP with ACI 530, the strength checks are roughly similar, although they are not directly comparable. While working stress design uses allowable values and safety factors, and strength design uses load factors and ultimate strengths, neither procedure is expected to provide results that are substantially different from the other. The detailing checks and design parameters are also similar, but the parameters NEHRP sets are more stringent, such as smaller limits on maximum size of reinforcement, exclusion of bundling of reinforcing bars, and longer hook development lengths in tension. Thus, the two sections are not equivalent in terms of detailing requirements. In summary, the two chapters are judged equivalent in intent, but are judged not equivalent in terms of detailing requirements and design parameters.

### 4.2.9 Chapter 9: Wood Structure Design Requirements

Both BOCA and NEHRP adopted 1991 National Design Specification for Wood Construction (NDS) by AFPA without modifications. However, BOCA is more restrictive in the use of certain materials, especially particleboard. Since BOCA is slightly more restrictive, the two documents are judged equivalent with regard to wood design requirements.

## 4.3 Conclusions Regarding BOCA

The 1996 BOCA had relatively few changes regarding seismic and material design provisions. The sections in which the 1996 BOCA and 1994 NEHRP Provisions are judged not equivalent are as follows:

- Seismic design values for structures
- Seismic design values for nonstructural components
- Precast concrete frame design requirements
- Strength and failure of concrete anchors
- Composite lateral force resisting systems and element design requirements
- Masonry detailing requirements and design parameters

While the design provisions for most major structural materials including steel, concrete and wood are essentially equivalent, the differences in seismic design values will result in a higher level of safety for structures designed using the NEHRP Provisions. The 1996 BOCA and the 1994 NEHRP are therefore judged not equivalent.

# 5.0 COMPARISON OF 1997 UBC TO 1994 NEHRP

Previous reports concluded that the 1994 UBC and the 1991 NEHRP Provisions were substantially equivalent. Since that time, changes have occurred in both documents which may or may not be equivalent. This section summarizes the changes and makes a comparison between the current versions of both documents. Further documentation of changes and detailed side-by-side comparisons are contained in Tables 2A and 2B.

## 5.1 Overview of UBC Provisions

The International Council of Building Officials (ICBO) assembles the Uniform Building Code (UBC). The seismic provisions are based on the SEAOC Blue Book which is published by the volunteer efforts of the Structural Engineers Association of California. The stated intent of the code is to provide minimum standards to safeguard life or limb, health, property and public welfare.

Seismicity maps are used to assess the seismic hazard of a particular region, and forces and seismic design requirements are increased with increased seismic hazard. Higher levels of performance are obtained by increasing the design base shear through the use of an importance factor (I). In the base shear equation, a factor (R), which accounts for system response and ductility, reduces the ground motion to a design level. The design base shear varies with 1/T, where T is the period of the structure.

The changes between the 1994 and the 1997 editions of the code are summarized below. Chapters 16 through 19, and 21 through 23 in the 1997 code are included in this comparison.

The UBC seismic design provisions were substantially revised in the 1997 edition. The design basis was changed from allowable stress to strength based. Additional variables were added to the base shear equation to consider distance to seismic source, seismic source type and new soil profiles. A new simplified static procedure was added for use on certain simple buildings. Earthquake forces are now a combination of horizontal and vertical loads. The horizontal load is multiplied by a redundancy factor that penalizes nonredundant buildings. The maximum inelastic response displacement is calculated using a ductility factor for the system.

The formulas for calculating loads on nonstructural elements were revised. Response coefficients for the elements are included and the vertical location of the equipment in the building is now a consideration. To match the measured response in buildings in recent earthquakes, the loads that result from the new equations are generally higher. New required design loads for anchorage to flexible diaphragms have been given.

The materials chapters did not undergo substantial changes.

Comparisons between the substantial changes in each document are summarized in the following section. The comparisons are arranged according to 1994 NEHRP chapters. For a more detailed and inclusive comparison, see Tables 2A and 2B.

## 5.2 Comparison of UBC to NEHRP

### 5.2.1 Chapter 1: General Provisions (and Testing & Inspection)

The soil classifications in the 1997 UBC were revised to match the 1994 NEHRP Provisions. Therefore, the soil types are equivalent.

Both documents introduced new seismic coefficients. Other than seismic zone 4 near field effects in UBC, the coefficients are the same. Since the near source factors are intended to equate UBC with revised seismicity maps in 1997 NEHRP, and the factors will only increase the coefficients, UBC is more stringent and the documents are judged equivalent with regard to seismic coefficients.

In UBC, continuous special inspection is required for various items unless periodic inspection is allowed by project plans and specifications and approved by the building official. NEHRP specifically outlines the requirement for continuous or periodic special inspection. Comparison between the documents was based on an assumption of continuous special inspection in UBC. In the case where periodic special inspection is allowed, provisions in NEHRP may be more stringent. NEHRP has provisions for special inspection of wood, architectural, mechanical and electrical components which UBC does not. Since the inspection provisions are in place, and use of the provisions can be implemented at the discretion of the design professional, UBC is judged equivalent in this regard.

### 5.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads)

With the change to strength design in UBC, a direct comparison of the documents is possible. The base shear formulas in the documents are similar. System ductility factors (R), however, are not necessarily the same in both documents and there is no consistent trend toward higher or lower values in either document. To match higher seismicity near active fault zones that is included in the 1997 NEHRP, near field factors, which can increase the base shear, have been included in UBC. Importance factors, which can also increase the base shear, are included in UBC but not in NEHRP. Another difference is the dependence on the building period. The base shear is proportional to 1/T in UBC and is proportional to $1/T^{2/3}$ in NEHRP. Therefore, for buildings with a period greater than 1 second, with all other variables being equal, NEHRP loads will be larger and the documents are not equivalent for long period structures. With near field effects and importance factors, UBC loads will generally be larger in high seismic zones and the documents are judged equivalent in this regard. Therefore, the documents are judged equivalent in structural design, criteria, analysis and procedures with the exception of long period structures.

UBC added a simplified static procedure which allows a simplified base shear calculation for certain structures. Although NEHRP does not have a simplified static procedure, the UBC formula results in loads that are larger than the equivalent lateral static force procedure, so UBC is more stringent and the documents are judged equivalent with regard to simplified base shear.

Since the load combinations in both documents are based on ASCE 7, they are equivalent. Both documents include a vertical earthquake load that depends on the dead load of the structure. The horizontal earthquake load in UBC is multiplied by a redundancy factor. The redundancy factor can never be less than 1 and can be as high as 1.5. UBC also includes near field and importance factors on the vertical earthquake loads. These factors may increase but not decrease the loads. Therefore, the earthquake load combination factors in UBC will always be greater than or equal to NEHRP. Thus, the documents are judged equivalent with regard to load combinations.

The drift limits prescribed by NEHRP are more stringent than UBC. Drift is usually a measure of damage, not life safety, and is usually only a concern in frame buildings. Therefore, with respect to the life-safety performance level, the documents are equivalent in intent, but not equivalent in design values and damage control. For higher performance levels, UBC evaluates drift at higher force levels, and NEHRP also uses more restrictive limits for higher performance. Therefore, the documents are equivalent in intent but not in drift design values.

To calculate inelastic drift, both documents amplify the design level deflections. NEHRP uses a deflection amplification factor and UBC uses a multiple of the ductility factor. There is no consistent trend toward higher or lower values in either document. Thus, the documents may be judged to be essentially equivalent in calculating inelastic drift.

The provisions for seismically isolated structures are equivalent in the documents. In requiring a dynamic analysis, NEHRP is more stringent. However, since the scaling of base shear to static levels is allowed, the design force levels will be equivalent, and the documents are judged equivalent in this regard.

The requirements for nonbuilding structures are equivalent. UBC does not contain requirements for passive energy dissipation systems. Since the section is located in an appendix in NEHRP, the provisions are just an introduction to the system. Therefore, the documents may be judged to be equivalent.

### 5.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements

The formulas used to calculate the load on nonstructural components are similar in both documents. Both documents revised the formula to depend on system amplification, flexibility and the vertical location of the equipment in the building. UBC has near field factors in seismic zone 4 which may increase the load. The importance factors in NEHRP are related to the importance of the component for safety. The importance factors in UBC tend to depend on the importance of the structure that the component is located in rather than the importance of the component. Therefore, the two documents are judged equivalent for architectural, mechanical, and electrical component design requirements with the exceptions that follow.

The loads on parapets are higher in NEHRP. The response factor for parapets in NEHRP is half of that in UBC and the importance factor for parapets is 50% higher, resulting in substantially higher design forces for parapets.

New requirements for anchorage to flexible diaphragms are included in UBC. UBC requires a 50% increase in loads when there is a connection to a flexible diaphragm, whereas NEHRP requires a 100% increase in loads in the center half of a flexible diaphragm span. Thus, with all other variables being equal, loads produced by NEHRP will be larger than UBC.

NEHRP contains additional requirements for bracing nonstructural items such as suspended ceilings and access floors that are not included in UBC.

### 5.2.4 Chapter 4: Foundation Design Requirements

The foundation design requirements may be judged to be essentially equivalent. UBC added requirements relating to expansive soils, post-tensioned slabs and minimum amounts of reinforcement that are not in NEHRP.

NEHRP requires ties between spread footings whereas UBC does not. This is the only issue in the foundation design requirements that the documents are not strictly equivalent. This issue is not considered to have a significant impact on the safety of a design, thus the two documents are judged substantially equivalent with regard to foundation requirements.

### 5.2.5 Chapter 5: Steel Structure Design Requirements

Both documents reference Seismic Provisions for Structural Steel Building, Load and Resistance Factor Design and Allowable Stress Design, all by AISC. Since these form the basis of the design provisions, the documents are essentially equivalent in design procedures. Modifications that were made to the references are essentially equivalent.

UBC included a new section on the requirements for special truss moment frames that is not included in NEHRP making it more restrictive. Thus, the two documents are judged equivalent with regard to steel design requirements.

### 5.2.6 Chapter 6: Concrete Structure Design Requirements

Although both documents reference ACI 318 for design provisions, NEHRP references an earlier version. Since a later version of ACI 318 may be assumed to be at least equivalent to, if not better than, the older version, UBC is more stringent. Therefore, the documents are judged equivalent with regard to concrete design requirements with the exceptions that follow.

Both documents added provisions for precast and plain concrete elements. Since NEHRP includes requirements that are not in UBC, the documents are not equivalent with regard to precast and plain concrete.

The application limits for concrete moment frames are more stringent in NEHRP. NEHRP requires that moment frames on soil profile type E or F with seismic performance category (SPC) B be an intermediate moment frame. SPC B tends to be in a lower seismic zone than the zones corresponding to requirements for intermediate frames in the UBC. Therefore, the documents are not equivalent in the application limits for concrete moment frame construction.

### 5.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements

In the 1994 edition of NEHRP, composite lateral force resisting systems are specifically addressed, and a new chapter was added. UBC does not specifically address composite systems, but allows them as long as they are designed using well established principles of mechanics. The composite system chapter in NEHRP mainly references other materials sections but also includes other requirements. The references that NEHRP uses are also referenced in UBC. Since UBC does not specifically address composite systems in the detail that NEHRP does, the documents are judged not equivalent with respect to composite systems. However, equivalence could be met if the user were to adopt the specific provisions of the composite systems chapter in NEHRP.

### 5.2.8 Chapter 8: Masonry Structure Design Requirements

With the change in emphasis to strength based design in NEHRP, the design basis in the documents is equivalent.

### 5.2.9 Chapter 9: Wood Structure Design Requirements

Both documents reference the 1991 National Design Specification for Wood Construction (NDS) by AFPA for wood design. There were no substantive changes to the portion of the wood design provisions in either document, therefore, the two documents are judged equivalent with regard to wood design requirements with the exceptions that follow.

In NEHRP, the limit for conventional construction is based on seismic performance category and number of stories in the building. UBC bases conventional construction limits on the type of occupancy, without regard to number of stories or seismic zone. With regard to residences, NEHRP is more stringent since UBC allows all 1-3 story residences to be constructed of conventional construction, whereas the number of stories in NEHRP is limited by the seismic performance category. With regard to standard occupancy structures, UBC is more stringent since the structure is limited to a single story whereas in NEHRP, depending on the seismic performance category, a higher number of stories may be allowed. The required braced wall spacing is more stringent in NEHRP.

NEHRP does not allow any material other than structural use panels to resist earthquake loads whereas UBC allows other materials. Therefore, NEHRP in general is somewhat more stringent for residential construction, and the documents are not equivalent in this regard.

## 5.3 Conclusions Regarding UBC

The 1997 UBC was substantially revised to utilize a strength based design approach. The seismic design basis change in UBC allowed a more direct comparison of the documents. The 1997 UBC and 1994 NEHRP are judged equivalent in intent and essentially equivalent in design values with the following exceptions:

- Design base shear for long period buildings without near field and importance factors
- Drift limits
- Design loads on parapets
- Design loads for anchorage to flexible diaphragms
- Composite lateral force resisting systems and element design requirements
- Application limits for intermediate concrete moment frames
- Wood conventional construction limits for residences
- Bracing requirements for access floors and suspended ceilings
- Requirements for precast and plain concrete

# 6.0 COMPARISON OF 1997 SBC TO 1994 NEHRP

Previous reports concluded that the 1994 SBC and the 1991 NEHRP Provisions were substantially equivalent. Since that time, changes have occurred in both documents which may or may not be equivalent. This section summarizes the changes and makes a comparison between the current versions of both documents. Further documentation of changes and detailed side-by-side comparisons are contained in Tables 3A and 3B.

## 6.1 Overview of SBC Provisions

The Southern Building Code Congress International (SBCCI) assembles the SBCCI Standard Building Code (SBC). The stated intent of the code is to serve as a comprehensive regulatory document to guide decisions aimed at protecting the public's life, health, and welfare in the built environment. Since 1994, SBC has incorporated the NEHRP Provisions for seismic design. Thus, the methodology of the code is the same as NEHRP. It uses a strength-based approach, the same seismicity maps, the same seismic performance categories, the same R values, and the seismic forces vary with the inverse of $T^{2/3}$.

The changes between the 1994 and 1997 editions of the SBC are summarized below. Chapters 16 through 19, and 21 through 23 in the 1997 code are included in this comparison.

Few changes were made to formulas calculating seismic forces for structural, architectural, mechanical and electrical components. These sections have remained essentially the same from the 1994 to the 1997 edition.

Few changes were made to provisions regarding foundation design requirements. The foundation wall section was the only section that was modified. It was rewritten to incorporate ACI 530/ASCE 5/TMS 402-95 and ACI 318-95.

The materials sections changed to the extent that SBC has adopted the most current standards with few modifications. SBC refers to AISC and AISI for steel, ACI for concrete and masonry, and AFPA for wood. SBC, however, included new restrictions on the use of particleboard in subflooring and roof sheathing in the wood section.

Comparisons between the substantial changes in each document are summarized in the following section. The comparisons are arranged according to 1994 NEHRP chapters. For a more detailed and inclusive comparison, see Tables 3A and 3B.

## 6.2 Comparison of SBC to NEHRP

### 6.2.1 Chapter 1: General Provisions (Testing & Inspection)

SBC did not adopt the changes to the soil factors and seismic performance categories introduced in NEHRP. The $C_a$ and $C_v$ factors included in NEHRP result in higher calculated seismic forces for soil profiles C, D, and E, especially in regions of low seismicity. Although the new factors result in slightly lower forces for soil profile A and equal forces in soil profile B, the documents are judged not equivalent with regard to soil factors.

SBC has similar requirements regarding testing and inspection or structural components. However, SBC did not incorporate testing and inspection changes made to the architectural, electrical, and mechanical components. Thus, two sections are judged equivalent with regard to structural components and not equivalent for architectural, electrical, and mechanical components.

### 6.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads)

For calculation of seismic forces for structural components, SBC did not adopt the changes introduced in NEHRP. The $C_a$ and $C_v$ factors included in NEHRP result in higher calculated seismic forces for very soft soils, especially in regions of low seismicity. Thus, NEHRP is more stringent than SBC and these sections are not equivalent.

### 6.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements

For calculation of seismic forces for architectural, mechanical, and electrical components, SBC did not adopt the changes introduced in NEHRP. The new formulas result in higher forces for nonstructural components. Thus, NEHRP is more stringent than SBC and these sections are not equivalent.

### 6.2.4 Chapter 4: Foundation Design Requirements

Few changes were made to foundation design requirements. In the SBC, the section on foundation walls was rewritten to incorporate ACI 530/ASCE 5/TMS 402-95 and ACI 318-95. The documents are judged to be equivalent with regard to foundation design requirements.

### 6.2.5 Chapter 5: Steel Structure Design Requirements

Both documents reference the same AISC and AISI standards without significant modification. Changes made to NEHRP either already existed in SBC or were also changed in SBC. In addition, SBC added requirements for cold-formed steel stud-wall systems that are more stringent than those in NEHRP. Since both documents reference the same standards, SBC and NEHRP are equivalent with regard to steel structure design requirements.

### 6.2.6 Chapter 6: Concrete Structure Design Requirements

Both documents adopt ACI 318, however, SBC did not adopt NEHRP modifications to ACI dealing with requirements for precast concrete frames. In addition, SBC did not adopt NEHRP changes regarding strength and failure of anchors. Thus, the documents are judged equivalent with regard to concrete structure design requirements except for precast concrete frames and strength and failure of anchors.

### 6.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements

There are no provisions in SBC regarding the design of composite lateral force resisting systems. While SBC does not prohibit composite design explicitly, it is silent on an approach to take to design a structure with a composite lateral-force-resisting system. Thus, NEHRP is more stringent with this type of structure and these documents are judged not equivalent with regard to structures with composite lateral force resisting systems.

### 6.2.8 Chapter 8: Masonry Structure Design Requirements

Regarding design of masonry structures, NEHRP has developed its own strength design guidelines while SBC has adopted ACI 530. ACI 530, however, uses working stress design provisions and modifies them to fit strength design guidelines. In comparing NEHRP with ACI 530, the strength checks are roughly similar, although they are not directly comparable. While working stress design uses allowable values and safety factors, and strength design uses load factors and ultimate strengths, neither procedure is expected to provide results that are substantially different from the other. The detailing checks and design parameters are also similar, but the limits NEHRP sets are more stringent, such as smaller limits on maximum size of reinforcement, exclusion of bundling of reinforcing bars, and longer hook development lengths in tension. Thus, the two sections are not equivalent in terms of detailing requirements. In summary, the two chapters are judged equivalent in intent, but are judged not equivalent in terms of detailing requirements and design parameters.

### 6.2.9 Chapter 9: Wood Structure Design Requirements

Both SBC and NEHRP adopted 1991 National Design Specification for Wood Construction (NDS) by AFPA without modifications. However, SBC is more restrictive in the use of certain materials, especially particleboard. Since SBC is slightly more restrictive, the two documents are judged equivalent with regard to wood design requirements.

## 6.3 Conclusions Regarding SBC

The 1997 SBC had relatively few changes regarding seismic and material design provisions. The sections in which the 1997 SBC and 1994 NEHRP Provisions are judged not equivalent are as follows:

- Seismic design values for structures
- Seismic design values for nonstructural components
- Precast concrete frame design requirements
- Strength and failure of concrete anchors
- Inspections of nonstructural components
- Composite lateral force resisting systems and element design requirements
- Masonry detailing requirements and design parameters

While the design provisions for most major structural materials including steel, concrete and wood are essentially equivalent, the differences in seismic design values will result in a higher level of safety for structures designed using the NEHRP Provisions. The 1997 SBC and the 1994 NEHRP are therefore judged not equivalent.

# 7.0 COMPARISON OF ASCE 7-95 TO 1994 NEHRP

Previous reports concluded that the ASCE 7-93 and the 1991 NEHRP Provisions were substantially equivalent. Since that time, changes have occurred in both documents which may or may not be equivalent. This section summarizes the changes and makes a comparison between the current versions of both documents. Further documentation of changes and detailed side-by-side comparisons are contained in Tables 4A and 4B.

## 7.1 Overview of ASCE 7 Provisions

The American Society of Civil Engineers (ASCE) assembles the Minimum Design Loads for Buildings and Other Structures (ASCE 7). This standard provides minimum vertical and lateral load requirements for the design of buildings and other structures that are subject to building code requirements. Model building codes will sometimes reference ASCE 7 for the determination of loads.

ASCE 7 contains all elements of a code, and for provisions unrelated to the determination of loads, ASCE 7 adopts NEHRP provisions with some revisions. The Appendix in ASCE 7 contains supplemental seismic provisions relating to quality assurance, foundation design, and structural materials.

Seismicity maps are used to assess the seismic hazard of a particular region, and forces and seismic design requirements are increased with increased seismic hazard. Similar to NEHRP, the seismic performance category of a structure, which is based on occupancy as well as the seismicity, determines the level of detailing and design requirements. The seismic performance category is used to obtain higher levels of performance, however, it does not influence the force level. In the base shear equation, a factor (R) which accounts for system response and ductility, reduces the ground motion to a design level. The design base shear varies with $1/T^{2/3}$, where T is the period of the structure.

The changes between the 1993 and the 1995 editions of the standard are summarized below. Chapters 1 through 9, and the Appendix in the 1995 standard are included in this comparison.

The 1993 edition of the standard adopted the 1991 NEHRP Provisions and subsequently, the 1995 edition adopted the 1994 NEHRP Provisions. Therefore, much of the changes that have occurred in ASCE 7 are similar to the changes that occurred in NEHRP. Changes related to the determination of loads, other than earthquake, were not documented since the changes to NEHRP were judged to be not significant.

In the materials sections, updated versions of the reference standards were used. The supplementary masonry provisions in the appendix were removed.

Comparisons between the substantial changes in each document are summarized in the following section. The comparisons are arranged according to 1994 NEHRP chapters. For a more detailed and inclusive comparison, see Tables 4A and 4B.

## 7.2 Comparison of ASCE 7 to NEHRP

### 7.2.1 Chapter 1: General Provisions (and Testing & Inspection)

ASCE 7 contains four seismic hazard exposure groups, whereas NEHRP has three. The two lowest hazard groups of ASCE 7 are encompassed by the lowest hazard group in NEHRP. In the determination of seismic performance category, ASCE 7 groups the two lowest hazard groups together. Thus, there is no implication to having a different number of groups. Therefore, the documents are judged equivalent with respect to general provisions with the exceptions that follow.

ASCE 7 requires quality assurance provisions for other designated seismic systems to apply to a larger number of seismic performance categories. However, ASCE 7 only requires the quality assurance provisions to apply to components with an importance factor of 1.5, whereas NEHRP does not have a similar specification. Therefore, NEHRP is more stringent for quality assurance provisions for other designated seismic systems.

ASCE 7 requires special inspection for the placement of concrete in deep foundations whereas NEHRP requires it for all foundations. Therefore, NEHRP is more stringent for other types of foundations, and the sections are not equivalent.

### 7.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads)

Similar to NEHRP, ASCE 7 made changes to the seismic coefficients used in the base shear equations. Therefore, with regard to structural design, criteria, analysis, and procedure, the documents are judged to be equivalent with the exceptions that follow.

NEHRP references the previous version of ASCE 7 for load combinations. In the new version of ASCE 7, fluid, soil and self-straining forces are not considered in combination with earthquake and wind forces, and in the current edition of NEHRP they are. In this case, the documents are judged to be not equivalent.

The drift limits prescribed for masonry buildings in NEHRP are more stringent than ASCE 7. Therefore, the documents are judged to be not equivalent with respect to masonry buildings.

### 7.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements

The formulas used to calculate the load on nonstructural components are similar in both documents. The formula was revised in both documents to depend on system amplification, flexibility and the vertical location of the equipment in the building. Both documents have the same importance factor and essentially the same response factors. Thus, the documents are judged to be equivalent with regard to architectural, mechanical, and electrical components design requirements with the exceptions that follow.

Powder-actuated fasteners are not allowed in NEHRP for seismic performance categories D and E, whereas ASCE 7 does not specifically disallow it. Therefore NEHRP is more stringent in prohibiting their use, and the documents are judged not equivalent with respect to powder-actuated fasteners.

The force requirements are higher in NEHRP for exterior wall panel connections. Thus, the documents are judged not equivalent in this regard.

### 7.2.4 Chapter 4: Foundation Design Requirements

The only difference that occurs between the documents with respect to foundation design is the load used to design foundation ties. While the design load will be larger in NEHRP when soft soil conditions are present, both documents will produce structures with foundation ties. Thus, with respect to foundation design the documents are judged to be essentially equivalent.

### 7.2.5 Chapter 5: Steel Structure Design Requirements

Both documents reference the same AISC standards with some modifications. The modifications made in each document are equivalent. Thus, the documents are judged equivalent with respect to steel structure design requirements.

### 7.2.6 Chapter 6: Concrete Structure Design Requirements

Although both documents adopt ACI 318, ASCE 7 did not adopt NEHRP modifications regarding precast concrete frames and strength and failure of anchors. Thus, the documents are judged equivalent with regard to concrete structure design requirements except for precast concrete frames and strength and failure of anchors.

### 7.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements

There are no provisions in ASCE 7 regarding the design of composite lateral force resisting systems. While ASCE 7 does not prohibit composite design explicitly, it is silent on an approach to take to design a structure with a composite lateral-force-resisting system. Thus, NEHRP is more stringent with this type of structure and these documents are judged not equivalent with regard to structures with composite lateral force resisting systems.

### 7.2.8 Chapter 8: Masonry Structure Design Requirements

Regarding design of masonry structures, NEHRP has developed its own strength design guidelines while ASCE 7 has adopted ACI 530. ACI 530, however, uses working stress design provisions and modifies them to fit strength design guidelines. In comparing NEHRP with ACI 530, the strength checks are roughly similar, although they are not directly comparable. While working stress design uses allowable values and safety factors, and strength design uses load factors and ultimate strengths, neither procedure is expected to provide results that are substantially different from the other. The detailing checks and design parameters are also similar, but the parameters NEHRP sets are more stringent, such as smaller limits on maximum size of reinforcement, exclusion of bundling of reinforcing bars, and longer hook development lengths in tension. Thus, the two sections are not equivalent in terms of detailing requirements. In summary, the two chapters are judged equivalent in intent but are judged not equivalent in terms of detailing requirements and design parameters.

### 7.2.9 Chapter 9: Wood Structure Design Requirements

Both documents reference 1991 National Design Specification for Wood Construction (NDS) by AFPA for wood design. The documents made equivalent changes to the strength based design provisions, construction limitations for conventional construction and shear panel sheathed with other sheet materials. Therefore, the documents are judged equivalent with respect to wood structure design requirements.

## 7.3 Conclusions Regarding ASCE 7

ASCE 7 incorporates the 1994 NEHRP Provisions with some revisions for all items that are not related to the determination of loads. ASCE 7-95 and 1994 NEHRP are judged to be equivalent in intent and design values with the following exceptions:

- Quality assurance provisions for other designated seismic systems
- Special inspection of concrete placement in foundations
- Masonry building drift limits, detailing requirements and design parameters
- Load combinations involving fluid, soil and self-straining forces
- Seismic application of powder-actuated fasteners
- Design load for the anchorage of exterior wall panels
- Precast concrete frame requirements
- Composite lateral force resisting system design requirements
- Strength and failure of concrete anchors

# 8.0 COMPARISON OF 1995 OTFDC TO 1994 NEHRP

Previous reports concluded that the 1992 OTFDC and the 1991 NEHRP Provisions were equivalent for conventional light frame dwellings two stories or 35 feet in height maximum, and townhouses of wood frame construction in areas where $A_v < 0.5$. Townhouses where $A_v \geq 0.05$ were judged not equivalent. Since that time, changes have occurred in both documents which may or may not be equivalent. This section summarizes the changes and makes a comparison between the current versions of both documents. Further documentation of changes and detailed side-by-side comparisons are contained in Tables 5A and 5B.

## 8.1 Overview of OTFDC Provisions

The Council of American Building Officials (CABO) assembles the CABO One and Two Family Dwelling Code (OTFDC). CABO consists of representatives from the three model code organizations of the United States, International Conference of Building Officials (ICBO), Building Officials and Code Administrators International (BOCA), and Southern Building Code Congress International (SBCCI). The model code organizations created CABO to provide consistency in code language throughout the three codes, Uniform Building Code (UBC), National Building Code (NBC), and Standard Building Code (SBC).

The scope of the One and Two Family Dwelling Code is limited to detached one- and two-family dwellings and one-family townhouses not more than three stories in height. The stated intent of the code is to provide minimum standards for the protection of life, limb, health, property, environment and for the safety and welfare of the consumer, general public, and the owners and occupants of residential buildings regulated by the code. OTFDC is a prescriptive code which is intended to be used by builders rather than engineers and architects. The code is intended primarily for conventional light frame construction and does not provide requirements for an engineered design. Additionally, the earthquake resistant provisions are minimal.

The changes between the 1992 and the 1995 editions of the code are summarized below. Chapters 1 through 8 in the 1995 code are included in this comparison.

The structural provisions chapters are arranged according to building components rather than building materials. The arrangement of the chapters was revised. OTFDC did not undergo any substantial changes to alter the general intent of the code. Additional detailing provisions were added and various tabulated values were revised.

Since the scope of OTFDC is limited, only items in NEHRP that are within the scope of OTFDC are used as a basis for comparison. Items in OTFDC that are not relevant to the comparison to NEHRP were not documented. Structures exempt from the provisions of NEHRP are one and two family dwellings with $C_a<0.15$ and one and two family wood dwellings not more than 2 stories with $C_a>0.15$ constructed in accordance with the prescribed conventional construction requirements. Therefore, the structures that are relevant to the comparison are one and two family dwellings that are not more than three stories in height with $C_a>0.15$ and one and two family three story wood dwellings with $C_a>0.15$. The conventional light frame construction provisions are also relevant to the comparison.

Comparisons between the substantial changes in each document are summarized in the following section. The comparisons are arranged according to 1994 NEHRP chapters. For a more detailed and inclusive comparison, see Tables 5A and 5B.

## 8.2 Comparison of OTFDC to NEHRP

### 8.2.1 Chapter 1: General Provisions (and Testing & Inspection)

Quality assurance and special inspection provisions in OTFDC are not prescriptive. The inspections that are commonly made in general practice are listed but requirements are not laid out. Therefore, the special inspection requirements default to the local jurisdiction, and comparison between the documents can not be made.

Similarly, testing requirements are not prescribed by OTFDC and will default to the local jurisdiction. Therefore, with testing requirements are outside the scope of OTFDC and these requirements are not relevant to the comparison.

In OTFDC, additions, alterations or repairs to any structure shall conform to the present code, however, the existing structure is not required to conform to the requirements of the present code. NEHRP states that an existing building addition shall be designed and constructed so that the entire building conforms to the seismic force resistance requirements for new buildings. Therefore, NEHRP is more stringent and the documents are judged not equivalent with respect to additions, alterations and repairs.

OTFDC allows for modifications to be made to the code if there are practical difficulties in conforming to the provisions. Since NEHRP does not have a similar provision that allows for modifications, the sections are judged not equivalent. Therefore, with respect to general provisions, the documents are judged equivalent with the exceptions as previously stated.

### 8.2.2 Chapter 2: Structural Design, Criteria, Analysis, and Procedure (Seismic Loads)

All provisions relating to the calculation of seismic base shear are not relevant to OTFDC. Since OTFDC is a prescriptive document, seismic loads are not calculated. Therefore, most of the provisions in Chapter 2 are not relevant to the comparison.

In OTFDC, standard masonry wall anchorage requirements are given. In NEHRP, the load must be calculated and the anchorage designed. For low seismic zones, the anchorage that OTFDC prescribes appears to be sufficient and equivalent to NEHRP. However, at higher seismic zones, OTFDC does not require an increased anchorage requirement and NEHRP requirements appear to exceed that of OTFDC. Therefore, for high seismic zones, the masonry wall anchorage requirements are judged not equivalent.

### 8.2.3 Chapter 3: Architectural, Mechanical, and Electrical Components Design Requirements

NEHRP contains anchorage requirements for many components that are not within the scope of a one or two family dwelling. In these cases, the comparison is not relevant. Force calculations are also not relevant to the comparison since OTFDC is a prescriptive document.

OTFDC does not contain bracing requirements for items such as parapets, veneer, wall panels and chimneys. NEHRP prescribes strict loads and the only exceptions are for components in seismic performance category A and components with a low risk to life safety in seismic performance category B. Therefore, with respect to architectural, mechanical and electrical components design, the documents are judged not equivalent.

### 8.2.4 Chapter 4: Foundation Design Requirements

The documents are judged to be essentially equivalent with respect to foundation design requirements. OTFDC prescribes geometric and material requirements for foundations that NEHRP does not.

NEHRP requires ties between footings whereas OTFDC does not. This is the only issue in the foundation design requirements that the documents are not strictly equivalent. Since this issue is not considered to have a significant impact on the safety of a design, the documents are judged substantially equivalent with regard to foundation requirements.

### 8.2.5 Chapter 5: Steel Structure Design Requirements

The only element of steel structure design that OTFDC covers is light framed walls and light framed elements in roof-ceiling construction. NEHRP references design documents for light framed wall requirements, whereas the only requirement in OTFDC is that elements in metal walls should be straight and free of any defects. Therefore, NEHRP is more stringent in the requirements of light framed walls and the sections are judged not equivalent.

### 8.2.6 Chapter 6: Concrete Structure Design Requirements

The concrete structure requirements in OTFDC relates to foundations and foundation walls. All other elements relating to concrete are outside the scope of OTFDC and are not relevant to the comparison.

For seismic performance category C in NEHRP, ACI 318.1 is referenced for minimum reinforcement around openings in basements and foundation walls. For seismic zones 0, 1 and 2 in OTFDC, minimum thickness and allowable depths of unbalanced fill are given for foundation walls. In addition, ACI 318.1 is a referenced standard in OTFDC. Therefore, the documents are judged equivalent for foundation walls in seismic performance category C.

For seismic performance categories D and E, NEHRP allows plain concrete basements walls in one and two family dwellings three stories or less in height provided the wall is not less than 7-1/2 inches thick and retains no more than 4 feet of unbalanced fill. For seismic zones 3 and 4 in OTFDC, the maximum amount of fill allowed without requiring reinforcement is 4 feet and the minimum wall thickness is 8 inches. Therefore, the sections are judged equivalent in these cases. However, a structure in seismic zone 2 may correlate to seismic performance category D. In this case, the maximum allowable unbalanced fill is larger and reinforcement other than around openings is not required. Therefore, for structures in seismic zone 2 assigned to seismic performance category D, the sections are judged not equivalent.

### 8.2.7 Chapter 7: Composite Steel and Concrete Structure Design Requirements

Composite steel and concrete structure design is outside the scope of OTFDC. Therefore, the comparison of this chapter is not relevant.

### 8.2.8 Chapter 8: Masonry Structure Design Requirements

The masonry structure requirements in OTFDC relates to foundations, foundation walls and walls. All other elements relating to masonry are outside the scope of OTFDC and are not relevant to the comparison. Both documents reference ACI 530/ASCE 5/TMS 402-91.

Since both documents reference the same standard, they are judged equivalent with the exceptions that follow. NEHRP includes some basic requirements relating to isolation of masonry partition walls from the basic structural system, roughened surface exposure, bundling of bars and development of reinforcement that are either not in OTFDC or not equivalent to it.

### 8.2.9 Chapter 9: Wood Structure Design Requirements

The conventional construction limitations are more stringent in NEHRP. NEHRP prescribes limitations in the number of stories for conventional construction according to seismic performance category. OTFDC allows all one and two family dwellings with no more than 3 stories to follow prescriptive requirements similar to conventional construction. NEHRP references OTFDC for conventional construction provisions, therefore, when conventional construction is permitted in NEHRP, the sections are equivalent. In the cases where conventional construction is not permitted in NEHRP, but is still within the scope of OTFDC, NEHRP requires an engineered structure and the documents are not equivalent. The structures within the scope of OTFDC that are not permitted to be conventional construction in NEHRP are 3 story SPC C, 2 and 3 story SPC D and all SPC E structures.

NEHRP requires the use of bracing walls at a specified spacing. OTFDC requires let in bracing at a specified spacing. Therefore, NEHRP is more stringent and the sections are not equivalent.

## 8.3 Conclusions Regarding OTFDC

NEHRP references OTFDC for conventional construction provisions. Therefore, for the structures that NEHRP will allow conventional construction to be used, the documents are judged equivalent. A disparity exists between the documents on which structures require nonconventional construction. The structures that require an engineered design in NEHRP that are still within the scope of OTFDC are 3 story SPC C, 2 and 3 story SPC D, and all SPC E structures. Since the earthquake resistance provisions are minimal in OTFDC, structures that require an engineered design in NEHRP are judged not equivalent. Other items in which the documents are judged not equivalent are as follows:

- Provisions for an existing building with an addition
- Masonry wall anchorage requirements
- Anchorage requirements for architectural elements
- Light framed metal wall requirements
- Masonry detailing
- Wall bracing requirements
- Limits in application of plain concrete in SPC D

# 9.0 CONCLUSIONS

In this report, the 1994 NEHRP Provisions are compared to five model building codes and standards including the 1996 BOCA, 1997 UBC, 1997 SBC, ASCE 7-95 and the 1995 OTFDC. Preceding comparison reports judged the previous editions of these codes substantially equivalent. Therefore, this study addressed only changes that have occurred between the current and previous editions of each model code and standard.

Changes between editions were documented, the impact of the changes were evaluated, and comparisons were made to the 1994 NEHRP Provisions. In the comparison, the documents were judged equivalent if the model code or standard provisions are equivalent to, or more stringent than, the requirements in NEHRP. The documents were judged not equivalent if the provisions in NEHRP are more stringent than the requirements in the model building code or standard. In comparing the documents, only changes that were judged to be substantive were documented.

The results of the comparison are summarized below. Detailed conclusions regarding the equivalence of each model code or standard can be found in the appropriate section.

The 1996 BOCA was judged not equivalent due to differences in seismic design values.

The 1997 UBC was judged equivalent with some exceptions noted.

The 1997 SBC was judged not equivalent due to differences in seismic design values.

ASCE 7-95 was judged equivalent with some exceptions noted.

The 1996 OTFDC was judged equivalent when conventional construction is applicable but not equivalent when engineered designs are required.

# REFERENCES


1. Assessment of the Seismic Provisions of Model Building Codes. NIST GCR 91598. Council of American Building Officials, July 1992.

2. Comparison of the Seismic Provisions of Model Building Codes and Standards to the 1991 NEHRP Recommended Provisions. NIST GCR 95-674. Melvyn Green & Associates, Inc., May 1995.

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

### CHAPTER 1: GENERAL PROVISIONS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 1.2 Scope | This section lists structures that are exceptions to seismic design provisions. Exceptions for one and two family dwellings that were previously dependent on Av, were revised to depend on a new coefficient Ca. | 1610.1 General | This section allows the loads to be determined from this section or ASCE 7-95. This change was incorporated because BOCA did not adopt the Ca and Cv factors of the 1994 NEHRP or ASCE 7-95. The 1996 BOCA still uses the Aa and Av factors from the 1991 NEHRP. | The 1996 BOCA deviates significantly here due to the fact it did not adopt the Ca and Cv factors used in the 1994 NEHRP. Thus, NEHRP is more stringent and the two sections are not equivalent. |
| 1.4.2 Seismic Coefficients | Six new soil profile types are defined in this section where previously there were 4. Seismic coefficients Ca and Cv, which depend on soil profile and seismic zone, are introduced in this section. Ca and Cv replace AaS and Av in the 1991 provisions. All provisions that were previously related to Av and Aa were revised to reflect the new coefficients. | 1610.3.1 Site Coefficient | No Changes | Since BOCA did not adopt the changes made to NEHRP, using NEHRP will result in higher seismic forces for soft soils, especially in regions of low seismicity. Thus, NEHRP is more stringent and the two sections are not equivalent for soft soils. |
| 1.4.4 Seismic Performance Category | The seismic performance category for seismic hazard exposure group III buildings with values of Av ranging from 0.15 to 0.20g was increased from C to D to reduce the risk of collapse in essential service buildings in regions of moderate seismicity. | 1610.1.7 Seismic Performance Category | No Changes | Since BOCA did not adopt the changes made to NEHRP, NEHRP is more stringent. Thus, the two sections are not equivalent. |
| 1.6.2.4 Special Inspection of Prestressed Concrete | The requirement for special inspection after the completion of placement of prestressing steel was added. | 1705.4.5 Inspection During Prestressing | No Changes | Since BOCA did not adopt the change made to NEHRP, NEHRP is more stringent. Thus, the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.8 Special Inspection of Architectural Components | The criteria for requiring special inspection changed from the performance criteria factor P, which depends on seismic hazard exposure group and the item to be braced, to the seismic performance category, which depends on Av and seismic hazard exposure group. Exceptions to periodic special inspection were added and additional items requiring inspection was added. | 1705.10 Wall Panels and Veneer | No Changes | BOCA only requires special inspection in Seismic Performance Category E. Since NEHRP requires special inspection in Seismic Performance Categories D and E it is more stringent. Thus, the two sections are not equivalent. |
| 1.6.2.9 Special Inspection of Mechanical and Electrical Components | The criteria for requiring special inspection changed from performance criteria P to seismic performance category (see above). The items requiring special inspection were revised. | 1705.11 Mechanical and Electrical Components | No Changes | BOCA only requires special inspection in Seismic Performance Category E. Since NEHRP requires special inspection in Seismic Performance Categories C, D and E, it is more stringent. Thus, the two sections are not equivalent. |
| 1.6.3.1.1 Testing of Reinforcing Steel | The requirement to examine the certified mill test reports for each shipment of reinforcing steel was defined to pertain to steel used to resist flexural and axial forces in reinforced concrete intermediate and special moment frames and boundary members of reinforced concrete or reinforced masonry shear walls. | | No equivalent section | Since BOCA has no provisions, NEHRP is more restrictive. Thus, the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 1.6.3.1.2 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is used to resist earthquake-induced flexural and axial forces in special moment frames and in wall boundary elements of shear walls in buildings of seismic performance category D and E, verify that the requirements of Sec. 21.2.5.1 of Ref. 6-1 have been satisfied. | | No equivalent section | Since BOCA has no provisions, NEHRP is more restrictive. Thus, the two sections are not equivalent. |
| 1.6.3.1.3 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is to be welded, verify that chemical tests have been performed to determine weldability in accordance with Sec. 3.5.2 of Ref. 6-1. | | No equivalent section | Since BOCA has no provisions, NEHRP is more restrictive. Thus, the two sections are not equivalent. |
| 1.6.3.4.3 Testing of Structural Steel | ASTM A435 and ASTM A898 are added criteria on which to judge the acceptability of base metal thicker than 1.5 in. that is subject to through-thickness weld shrinkage strains. | | No equivalent section | Since BOCA has no provisions, NEHRP is more restrictive. Thus, the two sections are not equivalent. |

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 2.2.5.1.2 Anchorage of Concrete or Masonry Walls | Although there were no changes in this section, the formula to calculate the anchorage force in section 3.1.3 was revised. | 1610.3.6.1.2 Concrete or Masonry Wall Anchorage | No Changes | Since BOCA did not adopt the change to the anchorage force, the change in NEHRP will result in a higher anchorage force. Thus, NEHRP is more stringent and the two sections are not equivalent. |
| 2.3.2.1 Calculation of Seismic Response Coefficient | In calculating Cs, the seismic response coefficient, Cv replaces AvS and Ca replaces Aa in the equations. Using these new coefficients, the base shear is lowered for structures on rock but is increased for structures on soft soils. The base shear of a structure is V=CsW. | 1610.4.1.1 Calculation of Seismic Response Coefficient | No Changes | Since BOCA did not adopt the change to the seismic response coefficient, NEHRP results in higher seismic forces for buildings on soft soils. Thus, NEHRP is more stringent and the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 2.6 Provisions for Seismically Isolated Structures | This is a new section based on the 1994 UBC Appendix Chapter 16, Division III. The provisions have been modified to conform to the strength based design approach and nomenclature of the document. | | No equivalent section | BOCA has no specific provisions for seismically isolated structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |
| 2.6.2.3 Seismic Hazard Exposure Group | All portions of the building shall be assigned a Seismic Hazard Exposure Group. | | No equivalent section | BOCA has no specific provisions for seismically isolated structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |
| 2.6.2.5.2 Equivalent Lateral Force Procedure | The provisions for using the equivalent lateral force procedure are included in this section. | | No equivalent section | BOCA has no specific provisions for seismically isolated structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |
| 2.6.2.5.3.3 Site Specific Design Spectra | The criteria that would require a site specific design spectra analysis is included in this section. | | No equivalent section | BOCA has no specific provisions for seismically isolated structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 2.6.6.2.8 Inspection and Replacement | Access for inspection and replacement of the isolation system shall be provided. | | No equivalent section | BOCA has no specific provisions for seismically isolated structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |
| 2.6.9.3 Determination of Force Deflection Characteristics | This section includes a formula to calculate the effective stiffness of an isolation system. | | No equivalent section | BOCA has no specific provisions for seismically isolated structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |
| 2.6.9.4 System Adequacy | This section includes the criteria to judge adequacy in test specimens. | | No equivalent section | BOCA has no specific provisions for seismically isolated structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |
| 2.7 Provisions for Nonbuilding Structures | This new section includes requirements to design all self-supporting structures, other than buildings, bridges and dams, that are supported by the earth, that carry gravity loads, and that may be required to resist the effects of an earthquake. | | No equivalent section | BOCA has no specific provisions for nonbuilding structures. While BOCA does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the two sections are not equivalent. |

# Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

## CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELETRICAL COMPONENTS DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 3.1 General | The requirements for architectural, mechanical, and electrical components have been revised. The exceptions to following the provisions are included. | 1610.6 Architectural, Mechanical, and Electrical Components and Systems | No changes | Since BOCA did not revise this section to include the new provisions, NEHRP is more stringent and the two sections are not equivalent. |
| 3.1.3 Seismic Forces | Previously, lateral force calculations for architectural and mechanical/electrical equipment were separated. In the new provisions, general formulas for all equipment are provided. The formulas depend on Ca, importance factor of the equipment, component amplification, response factors, and vertical location of the equipment in the building. | 1610.6.3 Architectural Component Design<br>1610.6.4 Mechanical, Electrical Component and System Design | This section added an exception to seismic forces for architectural component design of storage racks. The formulas used are still from the 1991 NEHRP. | Since BOCA did not revise the formulas, the NEHRP formulas will result in higher seismic forces for nonstructural components. Thus, NEHRP is more stringent and the two sections are not equivalent. |
| 3.1.4 Seismic Relative Displacement | This new section introduces formulas to calculate the relative displacement that may occur between components. | | No equivalent section | Since BOCA has no provision, NEHRP is more stringent. Thus, the two sections are not equivalent. |
| 3.1.5 Component Importance Factor | New importance factors are introduced which depend on the severity of failure of the component. | Table 1610.6.3<br>Table 1610.6.4 (1) | No Changes | Since BOCA did not revise this section, NEHRP is more stringent. Thus, the two sections are not equivalent. |
| 3.2.6 Suspended Ceilings | This new section outlines additional requirements for bracing suspended ceilings. Design and construction references and minimum clearances are among the additional requirements. | 1610.6.3.3 Ceilings | No Changes | Since BOCA did not revise this section, NEHRP is more stringent. Thus, the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 3.2.7 Access Floors | This new section outlines additional requirements for bracing access floors. The weight used to calculate loads and the requirements for special access floors are included. | | No equivalent section | Since BOCA has no provision, NEHRP is more stringent. Thus, the two sections are not equivalent. |
| 3.2.9 Steel Storage Racks | This new section outlines additional requirements for bracing steel storage racks. The weight used to calculate loads and the response factor to design the rack are included. | | No equivalent section | Since BOCA has no provision, NEHRP is more stringent. Thus, the two sections are not equivalent. |
| 3.3 Mechanical and Electrical Components | Extensive requirements for bracing various mechanical and electrical components such as piping, elevators, and storage tanks are provided. | 1610.6.4 Mechanical, Electrical Component and System Design | No Changes | Since BOCA did not revise this section, NEHRP is more stringent. Thus, the two sections are not equivalent. |

### CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 4.4.3 Foundation Ties | The design loads for foundation ties are revised because of the change in seismic coefficients. | 1810.2 Footing Seismic Ties | No Changes | The loads in NEHRP are larger when Ca is greater than 0.4, which occurs in regions of high seismicity with soft soils. Since no change was made to BOCA, NEHRP is more stringent under these conditions. Thus, the sections are not equivalent in high seismic zones on soft soils. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 6.1.1.5 | Requirements for connections of precast concrete elements that emulate the behavior of monolithic reinforced concrete construction were added. | 1903.1.1 Modifications to ACI 318-95 | No equivalent modification | Since BOCA does not have this modification, the modification results in NEHRP being more stringent. Thus, the two sections are not equivalent. |
| 6.1.1.7 | Requirements for strong connections of precast concrete frames were added. | 1903.1.1 Modifications to ACI 318-95 | No equivalent modification | Since BOCA does not have this modification, the modification results in NEHRP being more stringent. Thus, the two sections are not equivalent. |
| 6.1.1.8 | This section includes provisions for calculating the probable capacities of structural elements in precast concrete frames. | 1903.1.1 Modifications to ACI 318-95 | No equivalent modification | Since BOCA does not have this modification, the modification results in NEHRP being more stringent. Thus, the two sections are not equivalent. |
| 6.1.1.12 | This section contains additional requirements for concrete diaphragms. | 1903.1.1 Modifications to ACI 318-95 | No equivalent modification | Since BOCA does not have this modification, the modification results in NEHRP being more stringent. Thus, the two sections are not equivalent. |
| 6.2.2 Strength of Anchors | A provision was added that states that anchors shall be detailed so that the connection failure is initiated by the failure of the anchor steel rather than by the failure of the surrounding concrete. | 1913.1.2 Strength of Anchors | No Changes | BOCA does not distinguish the strength of anchors due to failure mode. NEHRP will provide a ductility failure mode, while BOCA may not. Thus, the two sections are not equivalent. |
| 6.2.3 Strength Based on Tests | The strength reduction factor for anchors shall be 0.8 when the anchor failure governs in the majority of tests and 0.65 when the concrete failure controls. | 1913.1.2 Strength of Anchors | No Changes | Since BOCA does not distinguish the strength of anchors due to failure mode, there are no strength reducing factors. Thus NEHRP is more stringent and the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 6.2.4 Strength Based on Calculations | The formula to calculate the tensile strength governed by concrete failure was revised. Two formulas which depend on the spacing of the anchors are given. | 1913.1.2.1 Strength in Tension | No Changes | Since BOCA did not revise the equations it will result in a higher calculated capacity when concrete failure governs. Thus, NEHRP is more stringent and the two sections are not equivalent. |
| 6.2.4.3 Combined Tension and Shear | The interaction equations to check the capacity for a combination of tension and shear were revised. The result of the change is less stringent interaction equations. | 1913.1.2.3 Combined Tension and Shear | No Changes | BOCA was more stringent than the previous version of NEHRP. However, with the modifications to NEHRP, BOCA only has two of the four equations in NEHRP. Thus, NEHRP is more stringent and the two sections are not equivalent. |
| 6.5.2 Moment Frames | A new provision was added that states that moment frames on soil profile type E or F with seismic performance category B shall be an intermediate moment frame. | | No equivalent section | Since BOCA has no equivalent section, NEHRP is more stringent. Thus, the two documents are not equivalent for seismic performance category B moment frames on soil types E and F. |

### CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| Chapter 7 Composite Steel and Concrete Structure Design Require-ments | This new chapter presents design and detailing requirements for composite structures that are expected to provide structural toughness, ductility, strength, and stiffness equivalent to comparable concrete and steel structures. | | No equivalent section | There is no equivalent section regarding composite design in BOCA. In addition, although not prohibiting composite design, BOCA is silent on any specific approach to take in designing a structure using a composite lateral-force-resisting system. Therefore, NEHRP is more stringent and the sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 7.2 Reference Documents | The reference documents are listed in this section. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.4 Composite Systems | Requirements to design composite systems (partially restrained frames, ordinary moment frames, special moment frames, concentrically braced frames, eccentrically braced frames, reinforced concrete walls composite with steel elements and composite shear walls) are in this section. The section outlines the design requirements for individual elements of the system. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.5 Composite Members | This section lays out the requirements for structural steel, reinforcing steel and concrete. The requirements refer to the steel and concrete codes. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.5.1 Composite Slabs | The requirements for designing composite slabs are included in this section. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.5.2 Composite Beams | Additional requirements for special moment frames are given as follows. A maximum distance from the maximum concrete compression fiber to the plastic neutral axis is given. Compression elements that are fully encased by a reinforced concrete cover (min. 2") do not need to meet the width-thickness ratio provided that concrete is confined by hoop reinforcement in regions where plastic hinges are expected to occur. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 7.5.3 Encased Composite Columns | This section references LRFD for the design of encased composite columns. Additional requirements for seismic performance category C, D and E are given. Most of the additional requireents are related to concrete reinforcing. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.5.4 Filled Composite Columns | This section outlines the requirements for filled composite columns. LRFD is referenced and additional requirements are given for seismic performance categories D and E. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.6 Composite Connections | This section includes requirements for connections in structures with composite or dual steel-concrete systems where seismic loads are transferred. | | No equivalent section | Since there is no equivalent section regarding composite design in BOCA, NEHRP is more stringent. Thus, the sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **1996 BOCA** | **Changes** | **Comments** |
| 8.1 General | The masonry structure design approach was changed from working stress design to limit states design. | 2101.2 Seismic Requirements (2104.0 Seismic Require-ments) | This section incorporates ACI 530/ASCE 5/TMS 402-95 in its entirety. Modifications to this reference were removed. | ACI 530/ASCE 5/TMS 402-95 did incorporate strength design for the seismic provisions. Therefore, the methodology approach is the same. However, rather than develop a separate set of strength design provisions, the standard takes the existing working stress design methodology and uses load factors, phi factors, and a 3.325 increase of allowable working stress values. The detailing provisions in the standard essentially remain the same. In comparing ACI 530 and NEHRP, the formulas to calculate strength capacities appear to be equivalent, although NEHRP tends to be a bit more restrictive. In the detailing provisions, similar checks are required in both documents. However, NEHRP is more restrictive with the parameters it sets, such as maximum size of reinforcement, bundling of reinforcing bars, and hook development lengths in tension. Based on the comparison of ACI 530 and NEHRP, NEHRP appears to be more stringent. Thus, the sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 8.3.7 Seismic Performance Category C | The screen wall requirements were removed. Requirements for walls separated from the basic structural system were added. The restriction on use of structural clay nonload-bearing wall tile (ASTM C56) was removed. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not have provisions for walls separated from the basic structural system. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.3.8 Seismic Performance Category D | The required roughened surface exposure for concrete placement next to masonry that is not designed with a separation joint was increased from 1/16" to 1/8". | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS0 402-95 does not have provisions for roughened surface exposure for concrete placement next to masonry. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.4.3 Placement Limits for Reinforce-ment | Bundling of bars is no longer allowed. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 allows the use of bundled bars. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.4.5 Development of Reinforce-ment | The calculation of embedment length (Eq. 8.4.5.2) was modified. A requirement for 6 inches of minimum embedment length for wire was added. The calculation of embedment length for hooks (Eq. 8.4.5.4.2) was modified. Lap splices are no longer allowed in plastic hinge zones. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | Due to the equation parameters, a direct comparison was not possible. However, the equation in ACI 530/ASCE 5/TMS 402-95 only considers the diameter of the bar and the strength of steel. The equations in NEHRP also take into account clear cover and strength of masonry. Based on this, NEHRP may be considered more stringent and the two sections are not equivalent. |
| 8.5.4 Deformation Requirements | This section was rewritten to be consistent with the deformation criteria set forth in Chapter 2. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain deformation provisions, only strength provisions. Thus, NEHRP is more restrictive and the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 8.6.2 Design Requirements of Reinforced Masonry Members | The critical strain ratio was reduced from 0.003 to 0.002. The critical strain ratio, which occurs at the balanced condition, is used to calculate the maximum reinforcement ratio. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not define a critical strain ratio. Thus, NEHRP is more stringent and the two sections are not equivalent. |
| 8.7.3 Design of Reinforced Masonry Members | The equations to calculate shear strength in both the masonry and reinforcing steel were modified (Eq. 8.7.3.2-1, 8.7.3.3). | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses one equation for calculating the shear capacity, independent of the steel reinforcement provided. NEHRP uses separate equations for calculating shear capacities of masonry and steel. Since NEHRP is the more accurate of the two methods, is may be considered more stringent. Thus, the two sections are not equivalent. |
| 8.11.2 Confinement of Compressive Stress Zone | The requirement for confinement was changed from a strain limit to the plastic hinge zone regions. The definition of a confined compressive zone was added. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for confinement of the compressive stress zone. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.11.3 Flanged Shear Walls | A requirement was added that states that solid units shall be laid in running bond and 50% of the masonry units at wall intersections shall be interlocked. The effective width of flange in compression was changed from 1/6 of the wall height to 9 times the thickness of the web. The effective width of flange in tension was changed from 1/3 of the wall height to 3/4 of the wall height. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for flanged shear walls. Thus, NEHRP is more restrictive and the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 8.12 Wall Frames | The requirement of where plastic hinges shall be formed was removed. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frames. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.12.4 Reinforce-ment | A new restriction requires that actual yield strength shall not exceed 1.5 times the nominal yield strength. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame reinforcement. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.12.5 Wall Frame Beams | An additional restriction that the reinforcement ratio shall be less than 0.15f'm/fy was added. The maximum spacing of transverse reinforcement was increased from 1/4 of the beam depth to 1/2 of the beam depth. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame beams. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.12.6 Wall Frame Columns | The limit of factored axial compression force was changed from 0.30Anf'm to 0.15Anf'm. The limit of minimum column dimension was decreased from 32 inches to 24 inches. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame columns. Thus, NEHRP is more restrictive and the two sections are not equivalent. |
| 8.12.7 Wall Frame Beam-Column Intersection | The definition of the dimension of the beam-column intersection was changed from a multiple of the bar diameters to Eq. 8.12.7.1-1 and Eq. 8.12.7.1-2. A restriction that the shear stress shall not exceed 7 roots f'm was added. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame beam-column intersections. Thus, NEHRP is more restrictive and the two sections are not equivalent. |

## Table 1A: Changed Provisions in BOCA and NEHRP Judged Not Equivalent

| CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **1996 BOCA** | **Changes** | **Comments** |
| 9.9.1.2 Shear Panels Sheathed with Other Sheet Materials | Previously, light framed walls sheathed with lath and plaster, gypsum sheathing boards, gypsum wallboard, or fiberboard sheets could be used to resist earthquake forces. Except in conventional construction, new provisions do not allow sheet materials other than structural-use materials to be part of the seismic force resisting system. | 2501.0 Gypsum Board and Plaster | BOCA allows the use of gypsum board and plaster to resist seismic forces in wood-framed buildings. | Since the 1994 NEHRP does not allow the use of gypsum board and similar materials to resist seismic forces at all, it is more stringent. Thus, the sections are not equivalent for wood-framed buildings. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| CHAPTER 1: GENERAL PROVISIONS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **1996 BOCA** | **Changes** | **Comments** |
| 1.6 Quality Assurance | Quality assurance provisions now apply to other designated seismic systems in seismic performance category D. | 1701.0 General | No Changes | Since the quality assurance provisions is BOCA apply to all categories, it is more stringent than NEHRP. Thus, the two sections are equivalent. |
| 1.6.2 Special Inspection | No Changes | 1705.1 General | This section added a special exemption for Group U buildings that are accessory to a residential occupancy building. | Since NEHRP has no exemptions, BOCA is more restrictive. Thus, the two sections are equivalent. |
| 1.6.2.1 Foundation Special Inspection | The requirement for continuous special inspection for placement of concrete was added. The requirement for continuous special inspection for construction of drilled piles and caissons was changed to periodic inspection. The requirement for periodic inspection for placement of reinforcing steel was added. | 1705.8 Pile Foundations 1705.9 Pier Foundations | No Changes | Since BOCA already has the changes made to NEHRP, the two sections are equivalent. |
| 1.6.2.2.1 Special Inspection for Reinforcing Steel | The requirement for periodic special inspection during and upon completion of reinforcing steel placement in intermediate concrete moment frames and concrete shear walls was added. The requirement for periodic special inspection of the placement of steel in reinforced masonry shear walls and ordinary moment frames was deleted. | 1705.4.2 Installation of Reinforcing and Prestressing Steel | No Changes | BOCA requires special inspections of reinforcing steel for all types of construction. Thus, it is more restrictive than NEHRP and the two sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.2.2 Special Inspection for Reinforcing Steel | The requirement for continuous special inspection during the welding of reinforcing steel was defined to pertain to steel resisting flexural and axial forces in intermediate and special moment frames of concrete, and in boundary members of concrete shear walls. | 1705.4.2 Installation of Reinforcing and Prestressing Steel | No Changes | BOCA requires special inspections of reinforcing steel for all types of construction. Thus, it is more restrictive than NEHRP and the two sections are equivalent. |
| 1.6.2.3 Special Inspection of Concrete | The requirement for special inspection during and on completion of the placement of concrete for intermediate and special moment frames and boundary members of concrete shear walls was added. The requirement for periodic special inspection during placement of concrete in reinforced concrete frames and shear walls was deleted. | 1705.4 Concrete Construction | No Changes | BOCA requires special inspections of concrete for all types of construction (with some exceptions). Thus, it is more restrictive than NEHRP and the two sections are equivalent. |
| | No equivalent section | 1705.4.1 Materials | This section was reworded in regards to weldability of reinforcement requirements. The section previously stated that weldability of reinforcement that conforms to ASTM A706 needed to meet certain requirements. The section now states that weldability of reinforcement that <u>does not</u> conform to ASTM A706 needs to meet certain requirements. This may have been a typo in the previous code. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the two sections are equivalent. |
| 1.6.2.6.1 Special Inspection of Structural Steel Welding | An exception to continuous special inspection in lieu of periodic inspection for welds loaded to less than 50 percent of their design strength was added. | 1705.3.3.2 Welding | No Changes | Since BOCA did not adopt this change, it is more restrictive. Thus, the two sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.6.2 Special Inspection of Structural Steel Bolts | Bolts in connections identified as not being slip-critical or subject to direct tension need not be inspected for bolt tension other than to ensure that the plies of the connected elements have been brought into snug contact. | 1705.3.3 Erection | No Changes | Since BOCA did not adopt the change made to NEHRP, BOCA is more stringent. Thus, the two sections not equivalent. |
| 1.6.2.7.1 Special Inspection of Structural Wood | The requirement for continuous special inspection during field gluing operations was defined to be for elements of the seismic force resisting system. | 2301.2 Inspections | This section was added for installation of wood framing members. | Since both sections have added the same provision, the two sections are equivalent. |
| 1.6.2.7.2 Special Inspection of Structural Wood | The requirement for periodic special inspection for nailing, bolting, anchoring, and other fastening was defined to pertain to all seismic components. | 2301.2 Inspections | This section was added for installation of wood framing members. | Since both sections have added the same provision, the two sections are equivalent. |
| 1.6.3.1 Testing of Reinforcing Steel | The requirement for a sample at fabricator's plant and the testing of reinforcing steel used in certain applications was deleted. | | No equivalent section | Since the NEHRP provision was deleted, the two sections are equivalent. |
| | No equivalent section | 1705.12 Sprayed Cementitious and Mineral Fiber Fireresistive Materials | This section was added | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the two sections are equivalent. |
| | No equivalent section | 1705.13 Exterior Insulation and Finish Systems (EIFS) | This section was added | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the two sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 2.2.2 Structural Framing Systems | New building frame systems, particularly relating to composite systems, were added. R and Cd values for ordinary moment frames of reinforced concrete and intermediate moment frames of reinforced concrete were increased. | 1610.3.3 Structural Framing Systems | No Changes | BOCA does not have any provisions related to the design of composite systems. In addition, although BOCA does not prohibit composite design, there are no provisions to design a composite structure by rational analysis. Thus, the two sections are not equivalent when dealing with composite structures. In other structures, however, BOCA has an R value equal to or less than NEHRP's values. Thus, the sections are equivalent. |
| 2.2.6 Combination of Load Effects | Load combinations are referenced to ANSI/ASCE 7-93 which differ from the previously given combinations. In earthquake load combinations, the dead load factor is slightly higher but the live and snow load factors are typically lower. The vertical earthquake loads depend on Ca where they previously depended on Av. The new vertical loads will be less for soil profile A, equivalent for soil type B and in most cases they will be larger for soil types C, D and E. | 1610.3.7 Combination of Load Effects | This section changed loading combinations to match ASCE 7-95. However, rather than adopt the Ca and Cv factors, the Aa and Av factors from ASCE 7-93 are retained. | Since both documents reference the same standard, and BOCA references the most current edition of the standard, the sections are equivalent. |
| Table 2.2.7 Allowable Story Drift | The category for single story buildings in the allowable drift limit table was deleted. Previously there was no limit on the allowable drift for single story buildings in seismic hazard exposure group I. New stringent allowable drift limits have been specified for masonry buildings. | Table 1610.3.8 Allowable Story Drift | This table added allowable story drifts for masonry shear wall buildings. | Both codes have changed to reflect masonry shear wall buildings. Thus, the two sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 2.3.2 Seismic Base Shear | The statement regarding the amount of snow load to include in the dead load weight was deleted. | 1610.4.1 Seismic Base Shear | No Changes | Since BOCA did not adopt the change to NEHRP, it is more restrictive than NEHRP. Thus, the two sections are equivalent. |
| Appendix to Chapter 2 Passive Energy Dissipation Systems | This section introduces new techniques for incorporating energy dissipation devices into earthquake resistant buildings. This section is included as an appendix because it is intended to be an introduction. | | No equivalent section | Although BOCA does not have an equivalent section, the appendix in NEHRP is just an introduction to the systems. Therefore, the documents may be considered equivalent in this regard. |

### CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| | No equivalent section | 1803.0 Soil Boring and Sampling Procedure | This section replaces the Soil Test Procedure. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| 4.2.2 Soil Capacities | No Changes | (1805.5 Increased Rock Capacity) | This section, which allowed an increase in loadbearing capacity of Class 1 and Class 2 rock in certain cases, was removed. | Since no change was made to the 1994 NEHRP Provisions, the 1996 BOCA is more stringent. Thus, the sections are equivalent. |
| 4.2.2. Soil Capacities | No Changes | 1807.1 Design Loads | This section removed the provision to increase allowable soil loadbearing values. | Since no change was made to the 1994 NEHRP Provisions, the 1996 BOCA is more stringent. Thus, the sections are equivalent. |
| 4.5.2 Foundation Ties | Individual spread footings are required to have ties only for soft soil, whereas previously ties were required for conditions when the soil is anything other than rock. | 1810.2 Footing Seismic Ties | No Changes | By not changing this provision, the 1996 BOCA is more restrictive than the 1994 NEHRP. Thus, the sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| | No equivalent section | 1812.0 Foundation Walls | This section on Foundation Walls was rewritten, incorporating ACI 530/ASCE 5/TMS 402-95 and ACI 381-95. Minimum thickness tables were added for walls that do not need to be designed by ACI 530/ASCE 5/TMS 402-95 or ACI 318-95. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1815.4 Masonry and Plain Concrete | The unsupported height of plain concrete foundation piers was reduced. The previous limit was six times the plan dimension. This has been reduced to three times the plan dimension. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

### CHAPTER 5: STEEL STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 5.1 Reference Documents | *Seismic Provisions for Structural Steel Buildings* by AISC was added as a reference, and as a result, the length of this chapter was reduced. Part I is based on AISC *LRFD* and Part II is based on AISC *ASD*. Updated versions of *LRFD* by AISC and *Standard Specification, Load Tables and weight Tables for Steel Joists and Joist Girders* are referenced. Another new reference is *Load and Resistance Factor Design Specification for Cold-formed Stainless Steel Structural Members*. | Chapter 35 | BOCA references all of the same standards that NEHRP does. | Since both sections references the same standards, the sections are equivalent. |
| 5.2 Structural Steel Seismic Requirements | The design of structural steel members and connections to resist seismic forces shall be in accordance with ASD and LRFD. | 2203.1 General | No changes | Since BOCA already uses ASD and LRFD, the sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 5.2.1 Requirements for Special Concentrically Braced Frames | This section includes the modifications to the requirements of *Seismic Provisions for Structural Steel Buildings*. | 2203.2.1 Modifications to AISC Seismic Provisions | Three modifications to the AISC Provisions relating to load combinations and columns were removed. | Since BOCA does not have additional requirements for special concentrically braced frames, NEHRP is more stringent. However, the modifications BOCA removed were never present in NEHRP. Thus, the two sections are equivalent except in the case of special concentrically braced frames. |
| 5.3 Cold-Formed Steel Seismic Requirements | This section references *Seismic Provisions for Structural Steel Buildings* (1992), *Specification for the Design of Cold-Formed Steel Structural Members* (1986), and *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* (1991). Modifications to the references are included. The most notable modification is the use of an earthquake load factor of 1.0 instead of 1.5. | 2206.0 Formed Steel Construction | No changes | BOCA already has the changes NEHRP has made. Thus, the two sections are equivalent. |
| 5.7 Light-Framed Walls | *Specification for the Design of Cold-Formed Steel Structural Members, Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* and *Specification for the Design of Cold-Formed Stainless Steel Structural Members* are referenced. | 2204.4.1 Light Framed Walls | No changes | BOCA already has the changes NEHRP has made. Thus, the two sections are equivalent. |
| | No equivalent section | (2208.0 Reinforcing Steel) | This section, requiring testing of unidentified reinforcing steel, was removed. | Since neither document has this provision anymore, the two sections are equivalent |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 5.6.2 Seismic Perfomance Category C | No changes | 2204.3 Seismic Performance Category C | The additional requirement applying to braced frames was removed. | By removing the additional requirement, the two sections are equivalent. |
| | No equivalent section | 2205.0 Open-Web Steel Joist Construction | This section was changed to more clearly define seismic requirements and remove testing requirements. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 6.1 Reference Documents | The revised version of ACI 318-89 is used as a reference. The revised version includes Building Code Requirements for Structural Plain Concrete. | Chapter 35 Referenced Standards<br>1901.0 Concrete Design Standards | BOCA adopted ACI 318-95 for reinforced and plain concrete. | Since BOCA is using the later version of ACI 318, it is more up to date than NEHRP. Thus, the two sections are equivalent. |
| 6.1.1.4 | Requirements for precast elements that are part of the lateral-force-resisting system were added. | 1903.1.1 Modifications to ACI 318-95 | No Changes | BOCA already has this modification, but expands it to systems not satisfying the requirements of the chapter, making it more stringent. Thus, the two sections are equivalent. |
| 6.1.1.9 | No Changes | 1903.1.1 Modifications to ACI 318-95 | This section removed modification to ACI 318 Section 21.3.3.4. | Since BOCA is using the later version of ACI 318, it is more up to date than NEHRP. Thus, the two sections are equivalent. |
| 6.1.1.13 | Provisions for coupling beams were added. | 1903.1.1 Modifications to ACI 318-95 | No Changes | Since BOCA already has this modification, the two sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 6.5.1 Ordinary Moment Frames | New requirements for ordinary moment frames with seismic performance category B were added. | 1903.3.1 Ordinary Moment Frames in Seismic Performance Category B | No Changes | Since BOCA already had this provision, the two sections are equivalent. |
| 6.6.3 Plain Concrete | New requirements for plain concrete footings, walls in the basement, foundation, or other walls below the base with seismic performance category C were added. | 1904.3.1 Footings | This section added exceptions to the footing provisions. | The changes to both sections now make them equivalent. |
| 6.7.4 Plain Concrete | A new provision states that structural members of plain concrete are not permitted in buildings assigned to category D or E (with some exceptions). | 1904.4 Seismic Performance Category D and E | No changes | Since BOCA already had this provision, the two sections are equivalent. |
| Appendix to Chp. 6 Reinforced Concrete Structural Systems Composed from Inter-connected Precast Elements | A new appendix was added to introduce provisions for structural systems composed of precast concrete elements interconnected with dry connections. | | No equivalent section | Although BOCA does not have equivalent provisions, the appendix in NEHRP is just an introduction to the systems. Therefore, the sections may be considered equivalent. |
| | No equivalent standard | 1906.2 Cements | This section added ASTM C595 for cement conformance. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| | No equivalent section | 1906.5.2 Welding | This section reworded the welding procedures such that a specification is required on the construction documents. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent figure | Figure 1907.1.2 Weathering Probability Map for Concrete | The map was revised. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1907.1.2.1 Calculation of Water-Cementitious Material | This section revised the compliance of maximum water-cementititous ratio. Table 1907.1.3 was added. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1907.1.2.2 Limitations on Use of Certain Cementitious Materials | This section revised the limitations to those of ACI 318-95. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1907.1.3 Protection from Sulfate | This section revised protection from sulfate compliance from ACI 318-89 to Table 1907.1.3. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1908.2 Selection of Concrete Proportions | This section removed modifications to ACI 318. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1909.2 Removal of Forms and Shores, and Reshoring | This section was reordered. Schedules, submittals, and unshored construction were added to the section. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

# Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

## CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 8.1.2 Reference Documents | Thirty-five material standard references were added. | Chapter 35 Referenced Standards | Eleven of the standards referenced in NEHRP were not referenced in BOCA. However, most of those not referenced were testing standards or material standards not related to masonry. | Because BOCA does not reference all of the standards in NEHRP, the two sections are not equivalent. However, material standards are not that critical in terms of equivalence. |
| | No equivalent section | 2104.9.2 Joint Reinforce-ment | This section changed the allowable deformation of joint reinforcement using longitudinal wires. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| 8.3.2 Empirical Masonry Design | No change. Uses ACI 530/ASCE 5/TMS 402-92 in its entirety. | 2101.1.2.1 Limitations | This section changed from the applicability of the Empirical Masonry Design to limitations of the method. | Since BOCA has limitations on the use of Empirical Masonry Design, it is more stringent. Thus, the two sections are equivalent. |
| 8.3.2 Empirical Masonry Design | No change. Uses ACI 530/ASCE 5/TMS 402-92 in its entirety. | Table 2106.2 Allowable Compressive Stresses for Empirical Design of Masonry | This table decreased one strength requirement for masonry of hollow loadbearing units. | Since BOCA is using the more current values in ACI 530/ASCE 5/TME 402-95, it is more up to date than NEHRP. Thus, the two sections are equivalent. |
| | No equivalent section | 2108.3 Masonry Foundation Walls | This section added a provision concerning masonry foundation walls. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 2111.1.8 Weepholes | This section added a provision concerning weepholes. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| | No equivalent section | 2112.3 Support on Wood | This section added a restriction to glass-block panels supported by wood members to those designed for it. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| 8.3.9 Seismic Perfomance Category E<br>8A.8.1 Construction Requirements | The requirement for solid grouting of structural masonry that is not part of the seismic resisting system was removed. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does have provisions for solid grouting of structural masonry that is not part of the seismic resisting system. Thus, BOCA is more restrictive and the two sections are equivalent. |
| 8.3.10 Properties of Materials | The table containing values of the modulus of elasticity (8.3.10.2) was removed in lieu of calculating the modulus using Eq. 8.3.10.2. The values of modulus of rupture in Table 8.3.10.5.1 were revised. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses the table previously used in NEHRP. The table results in lower moduli in clay masonry and concrete masonry with a strength greater than 3000 psi. Since a lower modulus results in a lower stiffness, BOCA is more stringent except for concrete masonry with low strengths. Thus, the two sections are equivalent. |
| 8.3.12 Plate, Headed and Bent Bar Anchor Bolts | The calculations for the design axial and shear strengths were revised (Eq. 8.3.12.1-1, 8.3.12.1-2, 8.3.12.2-1, 8.3.12.2-2). | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | A comparison of the equations indicates that ACI 530/ASCE 5/TMS 402-95 is more stringent in two of the four equations. Thus, neither section is more stringent, the two sections may be considered equivalent. |
| 8.6.3 Design of Plain Unreinforced Masonry Members | The allowable flexural compressive stress for unreinforced masonry in non-seismic applications is now proportional to a strain up to 0.85f'm. The previous version limited this condition to 0.33f'm. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses the previous limit of 0.33f'm. Thus, BOCA is more restrictive and the two sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 8.7.2 Shear Strength | The 2/3 factor that was applied to shear strength when comparing it to the shear demand was removed. | 2101.2 Seismic Requirements | BOCA uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses working stress equations to determine shear and, thus, a direct comparison is not possible. However, since the intent of strength design is not to provide a more strigent method but to provide a more accurate method of design, the two sections may be considered equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| | No equivalent sections | 2113.0 Fireplaces and Chimneys Flues<br>2114.0 Masonry Chimneys, General Require-ments<br>2115.0 Masonry Chimneys for Low-Heat Appliances and Fireplaces.<br>2116.0 Masonry Chimneys for Medium-Heat Appliances<br>2117.0 Masonry Chimneys for High-Heat Appliances | These sections concerning masonry chimneys were either rewritten or added. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

### CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 9.1 Reference Documents | Several reference documents have new editions and there are a few new references. | Chapter 35 Referenced Standards | The referenced standards are more updated versions of the standards used by NEHRP. | Since BOCA uses the more updated version of standards, it is just as or more stringent than NEHRP. Thus, the sections are equivalent. |
| 9.4.1 Construction Limitations, Conventional Construction | The limits for conventional construction for buildings have been revised. The height of the building is no longer a criteria. The required spacing between braced walls has been increased for seismic performance categories A and B. Previously all SPC A buildings could use conventional construction, now there are limitations. Previously the maximum number of stories permitted for conventional construction of SPC C building was 1 and now it is 2. Previously SPC D buildings could not utilize conventional construction in seismic hazard exposure groups II and III, and now conventional construction may be used for one story buildings with a maximum distance between braced walls of 25 ft. | | No equivalent section | Since there are no conventional construction procedures in BOCA, it is more stringent than NEHRP. Thus, the sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 9.9.1.1 Structural-Use Shear Panels | There are no restrictions in the use of particleboards. | Table 2305.2 Fastening Schedule<br>2305.15.1 Roof Decking and Sheathing<br>2306.4.7 Particleboard Shear Wall Sheathing<br>2308.0 Particleboard | The use of particleboards is more restrictive in the 1996 BOCA than in the 1993 BOCA. Particleboards cannot be used as subflooring or roof sheathing unless it can be shown that it meets the requirements of wood structural panels. | Since there are no restrictions in NEHRP on the use of particleboards, BOCA is more stringent. Thus, the sections are equivalent. |
| | No equivalent table | Table 2305.2 Fastening Schedule | This table removed 1" or greater Wood Structural Panel Roof and Wall Sheathing and added several footnotes restricting nail spacing based on basic wind speed. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent provisions | 2305.6.3 Girder Supports<br>2305.18 Fire Cuts<br>2309.4 Wall Insulation | These documents changed to account for concrete walls as well as masonry walls. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent provision | 2305.14.1 Floor Spans | This section added bracing requirements of floors and roof spans. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

## Table 1B: Changed Provisions in BOCA and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| | No equivalent provision | 2305.16 Bridging | BOCA moved and rewrote the Bridging section. This section used to be part of the Flooring section. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent provision | 2305.17 Foundation Anchorage | This section reduced minimum anchor bolt embedment depth to 7 inches for both concrete and masonry. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |
| | No equivalent provision | 2309.4.1 Protection | This section added a requirement for protection of exterior fiberboard. | Since the 1994 NEHRP has no provisions, the 1996 BOCA is more restrictive. Thus, the sections are equivalent. |

# Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

## CHAPTER 1: GENERAL PROVISIONS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 1.2 Scope | This section lists structures that are exceptions to seismic design provisions. Exceptions for one and two family dwellings that were previously dependent on Av, were revised to depend on a new coefficient Ca. | 1629.1 Basis for Design | No major changes | Depending on the soil type, the change in parameters in NEHRP may require one and two story wood frame dwellings in seismic zone 1 to be designed to seismic provisions. This is more stringent than UBC where all one and two family dwellings in seismic zone 1 need not conform to seismic provisions. Thus, the sections are not equivalent. |
| 1.6.2.1 Foundation Special Inspection | The requirement for continuous special inspection for placement of concrete was added. The requirement for continuous special inspection for construction of drilled piles and caissons was changed to periodic inspection. The requirement for periodic inspection for placement of reinforcing steel was added. | 1701.5 Types of Work | No changes | Since UBC has exceptions for special inspection of the placement of concrete, the sections are not equivalent. Regarding piles and caissons, UBC is more stringent since continuous special inspection is required unless the building official allows periodic inspection. UBC is more stringent regarding reinforcing steel since UBC only allows for periodic special inspection (rather than continuous) under certain conditions. Therefore, the documents are equivalent with respect to piles and caissons and reinforcing steel. |
| 1.6.2.7.1 Special Inspection of Structural Wood | The requirement for continuous special inspection during field gluing operations was defined to be for elements of the seismic force resisting system. | | No equivalent provision | Since UBC does not have special inspection requirements for wood, the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.7.2 Special Inspection of Structural Wood | The requirement for periodic special inspection for nailing, bolting, anchoring, and other fastening was defined to pertain to all seismic components. | | No equivalent provision | Since UBC does not have special inspection requirements for wood, the sections are not equivalent. |
| 1.6.2.8 Special Inspection of Architectural Components | The criteria for requiring special inspection changed from the performance criteria factor P, which depends on seismic hazard exposure group and the item to be braced, to the seismic performance category, which depends on Av and seismic hazard exposure group. Exceptions to periodic special inspection were added and additional items requiring inspection was added. | | No equivalent provision | Since UBC does not have special inspection requirements for architectural components, the sections are not equivalent. |
| 1.6.2.9 Special Inspection of Mechanical and Electrical Components | The criteria for requiring special inspection changed from performance criteria P to seismic performance category (see above). The items requiring special inspection were revised. | | No equivalent provision | Since UBC does not have special inspection requirements for mechanical and electrical components, the sections are not equivalent. |
| 1.6.3.1.1 Testing of Reinforcing Steel | The requirement to examine the certified mill test reports for each shipment of reinforcing steel was defined to pertain to steel used to resist flexural and axial forces in reinforced concrete intermediate and special moment frames and boundary members of reinforced concrete or reinforced masonry shear walls. | | No equivalent provision | Since UBC does not have provisions for mill test reports, the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.2.2 Structural Framing Systems | New building frame systems, particularly relating to composite systems, were added. R and Cd values for ordinary moment frames of reinforced concrete and intermediate moment frames of reinforced concrete were increased. | 1629.6 Structural Systems | Three new structural systems were added. Structural system coefficients were revised, however the approach to calculating base shear was also revised. Values for R were proportionally scaled down due to the change to strength design. | Because of the new composite systems added in NEHRP, there are more structural system categories than UBC. UBC allows for composite systems in section 1605.2 which states that any system may be used provided it is based on a rational analysis in accordance with well-established principles of mechanics. Since UBC does not specifically allow composite systems, the sections are not equivalent. Equivalence between the documents could be demonstrated. In some cases R values in NEHRP are larger and in some cases they are smaller. The documents are essentially equivalent in their values. NEHRP includes R values for plain concrete and masonry wall structures that UBC does not. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.2.5.1.2 Anchorage of Concrete or Masonry Walls | Although there were no changes in this section, the formula to calculate the anchorage force in section 3.1.3 was revised. | 1633.2.8.1 Out of Plane Wall Anchorage to Flexible Diaphragms | This new section includes provisions for anchoring walls to flexible diaphragms. The requirements for connections to flexible diaphragms are more stringent than connections to rigid diaphragms. Using the formula that depends on system ductility (Eq. 32-2), the design load is 50% larger for flexible diaphragms. The minimum design load is 420 lb/ft which 50% larger than the minimum for rigid diaphragms. | NEHRP presents 2 formulas for calculating design forces. The first formula is similar to and will produce similar values as rigid diaphragms in UBC. The second formula in NEHRP depends on the system ductility. For flexible diaphragms in UBC the amplification factor is increased by 50%, whereas in NEHRP, it is doubled in the center half of the span. This puts NEHRP loads 33% higher in the center half of the diaphragm span. The minimum design value in NEHRP depends on Ca which will give a maximum value of 440lb/ft; this is 20 lb/ft greater than the minimum value required in UBC. Using the first formula for calculating the load, the documents will be equivalent. Using the second formula for calculating the load, NEHRP values are more stringent and the documents are not equivalent. Near field effects in seismic zone 4 will increase the loads in UBC. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.2.7 Deflection and Drift Limits | The category for single story buildings in the allowable drift limit table was deleted. Previously there was no limit on the allowable drift for single story buildings in seismic hazard exposure group I. New stringent allowable drift limits have been specified for masonry buildings. | 1630.10 Story Drift Limitations | Due to the change in design forces, the maximum allowable story drift was revised. The limit is 0.025 times the story height for structures with a period less than 0.7 seconds and 0.020 times the story height for structures with a period greater than 0.7 seconds. | The NEHRP drift limits are more stringent. NEHRP has strict drift limits that apply to masonry buildings which UBC does not. Drift is usually only a concern for frame buildings, in which case the sections are not equivalent. Drift is a measure of damage and not a life safety issue. In that respect, the documents are equivalent from a performance standpoint. |
| 2.3.2 Seismic Base Shear | The statement regarding the amount of snow load to include in the dead load weight was deleted. | 1630.2.1 Design Base Shear<br>1630.2.3 Simplified Design Base Shear | The method for calculating base shear was completely revised. The design level was changed from allowable stress to strength based. New soil categories, near field effect, and seismic source type are additional parameters used in calculating the base shear. A formula for a new simplified design base shear was added which produces loads larger than the static force procedure. The advantage of using the simplified base shear procedure is less calculation effort. | One of the main differences in the base shear calculation is that UBC includes near field and importance factors. These factors will only increase the base shear. The other difference is the dependence on the period. The base shear in UBC is proportional to 1/T whereas it is proportional to $1/T^{2/3}$ in NEHRP. For structures with a period greater than 1, with no concern for near field and importance, NEHRP loads will be larger. Thus, for long period standard occupancy structures that are not in the near field, the sections are not equivalent. For all other conditions, the sections are equivalent. Since the simplified static procedure in UBC is conservative, the sections are equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.3.2.1 Calculation of Seismic Response Coefficient | In calculating Cs, the seismic response coefficient, Cv replaces AvS and Ca replaces Aa in the equations. Using these new coefficients, the base shear is lowered for structures on rock but is increased for structures on soft soils. The base shear of a structure is V=CsW. | 1630.2.1 Design Base Shear | See above for discussion on base shear | See above for discussion on base shear |

**CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS**

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 3.1.3 Seismic Forces | Previously, lateral force calculations for architectural and mechanical/electrical equipment were separated. In the new provisions, general formulas for all equipment are provided. The formulas depend on Ca, importance factor of the equipment, component amplification, response factors, and vertical location of the equipment in the building. | 1632.2 Design for Total Lateral Force | New formulas for calculating the lateral force on nonstructural components are introduced. The force may be calculated with a simple formula that gives an upper bound to the load or by taking into account the type of equipment and vertical location of the equipment in the building. Response coefficients are included for different types of equipment. | The documents provide similar formulas for calculating the lateral force on nonstructural components. UBC includes near field effects in seismic zone 4 that may result in a higher load. The component coefficients vary in the two codes; in some instances NEHRP is higher and it is sometimes lower. Both documents have a penalty for non-ductile component anchorage. The importance factor in NEHRP is more component dependent than in UBC. With all factors considered, the sections are essentially equivalent. Parapet design loads are an exception. The response coefficient is smaller and the importance factor is larger in NEHRP. Therefore, with respect to parapets, NEHRP will produce larger loads and the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 3.1.5 Component Importance Factor | New importance factors are introduced which depend on the severity of failure of the component. | Table 16-K Occupancy Category | No changes | The importance factor for components that contain hazardous and essential substances are equivalent in the documents. NEHRP places a greater importance on components that may be a falling or egress hazard. Thus, in this respect, the documents are not equivalent. |
| 3.2.6 Suspended Ceilings | This new section outlines additional requirements for bracing suspended ceilings.<br>Design and construction references and minimum clearances are among the additional requirements. | Table 16-O Horizontal Force Factors | No changes relating to suspended ceilings | NEHRP contains more detailed requirements for suspended ceilings than UBC. Thus, the sections are not equivalent. They may be proven equivalent if NEHRP requirements are met. |
| 3.2.7 Access Floors | This new section outlines additional requirements for bracing access floors. The weight used to calculate loads and the requirements for special access floors are included. | Table 16-O Horizontal Force Factors | A new footnote states that only anchorage or restraints need be designed. | NEHRP contains more detailed requirements for access floors than UBC. Thus, the sections are not equivalent. They may be proven equivalent if NEHRP requirements are met. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 3.2.9 Steel Storage Racks | This new section outlines additional requirements for bracing steel storage racks. The weight used to calculate loads and the response factor to design storage racks is included. | Chp. 22 Div. X Design Standard for Steel Storage Racks | Consistent with changes to base shear, the calculation of earthquake loads was revised. | Both documents adopt the same reference design standard. NEHRP requires the seismic weight to be the weight of the storage rack plus 67% of the rated load. UBC requires the seismic weight to be the weight of the rack plus the contents. UBC allows for a 50% reduction in the weight of the contents if there are a minimum of four columns in any direction on each column line designed to resist horizontal forces. Thus, when UBC allows for reduction, the sections are not equivalent. |
| 3.3 Mechanical and Electrical Components | Extensive requirements for bracing various mechanical and electrical components such as piping, elevators, and storage tanks are provided. | Table 16-O Horizontal Force Factors<br>Various sections | The majority of the bracing requirements is in footnotes of Table 16-O. | NEHRP contains more detailed requirements for the various mechanical and electrical components. Thus, the sections are not equivalent. They may be proven equivalent if NEHRP requirements are met. |

### CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 4.5.2 Foundation Ties | Individual spread footings are required to have ties only for soft soil, whereas previously ties were required for conditions when the soil is anything other than rock. | | No equivalent section | Since UBC does not require ties for spread footings, the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 6.1.1.8 | This section includes provisions for calculating the probable capacities of structural elements in precast concrete frames. | | No equivalent provision | Since no equivalent provisions exist in UBC, the sections are not equivalent. |
| 6.2.2 Strength of Anchors | A provision was added that states that anchors shall be detailed so that the connection failure is initiated by the failure of the anchor steel rather than by the failure of the surrounding concrete. | 1923.2 Strength Design | No changes | Since UBC does not require a particular failure sequence, the sections are not equivalent. |
| 6.5.2 Moment Frames | A new provision was added that states that moment frames on soil profile type E or F with seismic performance category B shall be an intermediate moment frame. | 1921.8 Requirements for Frames in Seismic Zone 2 | No changes | UBC states that frames in seismic zone 2 are required to be intermediate moment frames. Without concern to soil type, NEHRP is more stringent since seismic performance category B tends to be in a lower seismic zone than zone 2. Thus, the sections are not equivalent. |
| 6.6.3 Plain Concrete | New requirements for plain concrete footings, walls in the basement, foundation, or other walls below the base with seismic performance category C were added. | 1922.6 Walls<br>1922.7 Footings | New requirements for structural plain concrete walls and footings were added. | The requirements in NEHRP and UBC do not tend to address the same issues. Requirements in NEHRP relate to minimum reinforcements and requirements in UBC are related to design loads. Since NEHRP has requirements that are not in UBC, the sections are not equivalent. |

# Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

## CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| Chapter 7 Composite Steel and Concrete Structure Design Requirements | This new chapter presents design and detailing requirements for composite structures that are expected to provide structural toughness, ductility, strength, and stiffness equivalent to comparable concrete and steel structures. | 1605.2 Rationality | No changes | UBC does not have a chapter dedicated to composite construction. UBC allows for composite systems in section 1605.2 which states that any system may be used provided it is based on a rational analysis in accordance with well-established principles of mechanics. Since UBC does not specifically allow composite systems, the sections are not equivalent. However, equivalence could be demonstrated. |
| 7.4 Composite Systems | Requirements to design composite systems (partially restrained frames, ordinary moment frames, special moment frames, concentrically braced frames, eccentrically braced frames, reinforced concrete walls composite with steel elements and composite shear walls) are in this section. The section outlines the design requirements for individual elements of the system. | 1605.2 Rationality | No changes | See above for discussion on composite systems. |
| 7.5.1 Composite Slabs | The requirements for designing composite slabs are included in this section. | Chapter 19 Concrete<br>Chapter 22 Steel | See specific material sections for any changes | Although NEHRP references sections common to UBC, it provides additional requirements. Thus, the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 7.5.2 Composite Beams | Additional requirements for special moment frames are given as follows. A maximum distance from the maximum concrete compression fiber to the plastic neutral axis is given. Compression elements that are fully encased by a reinforced concrete cover (min 2") do not need to meet the width-thickness ratio provided that concrete is confined by hoop reinforcement in regions where plastic hinges are expected to occur. | Chapter 22 Steel | See steel section for any changes | The documents are equivalent in composite beam design requirements since they both reference LRFD. Since NEHRP is less stringent in the width-thickness requirement, the documents are equivalent in this respect. Since NEHRP has an extra requirement for the maximum distance to the plastic neutral axis, the documents are not equivalent in this respect. |
| 7.5.3 Encased Composite Columns | This section references LRFD for the design of encased composite columns. Additional requirements for seismic performance category C, D and E are given. Most of the additional requirements are related to concrete reinforcing. | Chapter 19 Concrete<br>Chapter 22 Steel | See specific material sections for any changes | NEHRP requires additional concrete detailing that is similar to requirements in the ACI. Since UBC references LRFD and ACI the referenced provisions are the same but the concrete detailing would not be used in conjunction with steel as NEHRP requires it. Thus, the sections are not equivalent. |
| 7.5.4 Filled Composite Columns | This section outlines the requirements for filled composite columns. LRFD is referenced and additional requirements are given for seismic performance categories D and E. | Chapter 19 Concrete<br>Chapter 22 Steel | See specific material sections for any changes | NEHRP has additional requirements for composite columns that uses sections from various references. Although UBC references the same documents, the provisions are not required in conjunction with each other. Thus, the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 7.6 Composite Connections | This section includes requirements for connections in structures with composite or dual steel-concrete systems where seismic loads are transferred. | Chapter 19 Concrete<br>Chapter 22 Steel | See specific material sections for any changes | UBC does not have a section dedicated to composite connections. Much of the requirements in NEHRP reference documents that UBC references. Since there are additional requirements, the sections are not equivalent. |

### CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.3.7 Seismic Performance Category C | The screen wall requirements were removed. Requirements for walls separated from the basic structural system were added. The restriction on use of structural clay nonload-bearing wall tile (ASTM C56) was removed. | 2106.1.12.3 Special Provisions for Seismic Zone 2 | No changes | Since UBC does not have requirements for walls separated from the basic structural system, the sections are not equivalent. |
| 8.3.8 Seismic Performance Category D | The required roughened surface exposure for concrete placement next to masonry that is not designed with a separation joint was increased from 1/16" to 1/8". | 2106.1.12.4 Special Provisions for Seismic Zones 3 and 4 | The exception to having to use special provisions for seismic zones 3 and 4 changed from a particular type of building with Group M Occupancies (retail) to Group U Occupancies (private garages, carports, sheds, etc.). | Since UBC requires a roughened surface exposure of 1/16", NEHRP is more restrictive. Thus, in this regard, the documents are not equivalent. NEHRP does not have any exceptions to additional requirements for seismic performance category D whereas UBC allows for exceptions to be made for certain structures in seismic zones 3 and 4. Thus, the sections are not equivalent. |
| 8.4.3 Placement Limits for Reinforce-ment | Bundling of bars is no longer allowed. | Various Sections | No changes | Although UBC does not specifically address bundling of bars, it does state that no more than 2 bars may be located in a cell of a wall or a wall frame. Since it appears that NEHRP is more stringent, the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.4.5 Development of Reinforce-ment | The calculation of embedment length (Eq. 8.4.5.2) was modified. A requirement for 6 inches of minimum embedment length for wire was added. The calculation of embedment length for hooks (Eq. 8.4.5.4.2) was modified. Lap splices are no longer allowed in plastic hinge zones. | 2108.2.2.6 Development<br>2108.2.6.2.4 Reinforce-ment | No changes | With the change to the formula in NEHRP, the embedment length formulas are equivalent. UBC does not specify a minimum embedment for wire; the minimum embedment for all bars is 12 inches. Thus, UBC is more stringent and the sections are equivalent. In UBC, the required extension of a hook depends on the angle of the bend. The length required in NEHRP is almost equal to that in UBC when there is a 90 degree bend on the hook. For larger bends, UBC allows less extension, therefore the sections are not equivalent. Since UBC requires the center of a lap splice to be at the center of the member clear length (outside of the plastic hinge zone), the sections are equivalent. |
| 8.5.4 Deformation Requirements | This section was rewritten to be consistent with the deformation criteria set forth in Chapter 2. | 2108.2.4.6 Deflection Design<br>2108.2.3.2 Design Assumptions<br>2108.2.6.2.7 Pier Design Forces | There were no changes to the deflection limitations. The formula for calculating the effective moment of inertia was deleted. The code states that effects of cracking on member stiffness shall be considered. A formula to calculate the midheight deflection of a wall is given that incorporates the service and cracked moments. | The deflection limitations are equivalent. NEHRP gives a formula for calculating the effective stiffness whereas UBC does not. Thus, the sections are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.7.3 Design of Reinforced Masonry Members | The equations to calculate shear strength in both the masonry and reinforcing steel were modified (Eq. 8.7.3.2-1, 8.7.3.3). | 2108.2.3.6.2 Nominal Shear Strength | No changes | Outside the plastic hinge zones, and without the effect of tension loads, the formula in NEHRP will give larger shear capacities for masonry. Thus, the documents are not equivalent for this condition. The shear capacity of masonry in NEHRP is increased with compressive axial load and decreased with tension. In the plastic hinge zone, depending on the axial load, UBC capacities may be higher. Since the shear capacity of reinforcement is larger in UBC, the sections are equivalent. |

# Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

## CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 9.4.1 Construction Limitations, Conventional Construction | The limits for conventional construction for buildings have been revised. The height of the building is no longer a criteria. The required spacing between braced walls has been increased for seismic performance categories A and B. Previously all SPC A buildings could use conventional construction, now there are limitations. Previously the maximum number of stories permitted for conventional construction of SPC C building was 1 and now it is 2. Previously SPC D buildings could not utilize conventional construction in seismic hazard exposure groups II and III, and now conventional construction may be used for one story buildings with a maximum distance between braced walls of 25ft. | 2320.1 General<br>2320.4.1 Braced Walls Lines<br>2320.5.1 Braced Wall Lines | No changes. UBC allows the following structures to be constructed of conventional light frame: 1) 1-3 story residences 2) 1 story standard occupancy structures constructed on slab-on-grade 3) private garages, carports, sheds, agricultural buildings, fences over 6' high, tanks and towers 4) top story walls and roof of standard occupancy structures not exceeding 2 stories of wood framing 5) interior nonload-bearing partitions, ceilings and curtain walls in all occupancies. UBC requires braced walls in seismic zones 0-3 to be spaced at 34' and 25' in seismic zone 4. | The requirement for braced walls is more stringent in NEHRP. UBC requires a spacing of 25' in seismic zone 4 whereas NEHRP requires it in seismic performance categories C and D. Therefore, regarding braced walls, the documents are not equivalent. NEHRP bases limits of conventional construction on seismic performance category and number of stories. UBC bases it on type of occupancy and does not limit the stories of a building based on a specific zone. With regard to residences, NEHRP is more stringent since UBC allows all 1-3 story residences to be constructed of conventional construction, whereas the number of stories in NEHRP is limited by the seismic performance category. Therefore with regard to residences, the documents are not equivalent. With regard to standard occupancy structures, UBC is more stringent since the structure is limited to a single story whereas in NEHRP, depending on the seismic performance category, a higher number of stories may be allowed. Therefore, with regard to standard occupancy structures, the documents are not equivalent. |

## Table 2A: Changed Provisions in UBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 9.9.1.2 Shear Panels Sheathed with Other Sheet Materials | Previously, light framed walls sheathed with lath and plaster, gypsum sheathing boards, gypsum wallboard, or fiberboard sheets could be used to resist earthquake forces. Except in conventional construction, new provisions do not allow sheet materials other than structural-use materials to be part of the seismic force resisting system. | 2315 Wood Shear Walls and Diaphragms | No changes | UBC allows for the use of wood, particleboard and fiberboard sheathing to resist earthquake loads whereas NEHRP only allows for wood panels. Thus, the sections are not equivalent. |
| | No equivalent provision | 2316.2 Amendments | The form factor for lumber I beams and box beams were revised. The new equation makes the form factor 23% larger. | NEHRP does not have any additional requirements for form factor beyond what is in the NDS. Since the form factor is directly related to the flexural capacity, in UBC, the capacity will be larger for lumber I beams and box beams. Thus, the sections are not equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| CHAPTER 1: GENERAL PROVISIONS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **1997 UBC** | **Changes** | **Comments** |
| 1.4.2 Seismic Coefficients | Six new soil profile types are defined in this section where previously there were 4. Seismic coefficients Ca and Cv, which depend on soil profile and seismic zone, are introduced in this section. Ca and Cv replace AaS and Av in the 1991 provisions. All provisions that were previously related to Av and Aa were revised to reflect the new coefficients. | 1629.3 Site Geology and Soil Characteristics<br>1629.4 Site Seismic Hazard Characteristics<br>1636 Site Categorization Procedure | Six new soil profile types are defined in this section where previously there were 4. Seismic coefficients Ca and Cv, which depend on soil profile, seismic zone, distance to seismic source and seismic source type, are introduced in this section. Distance to seismic source and seismic source type were not previously considered. A new section, 1636, describes the procedure for determining soil profile type. | The soil classifications and procedures for determining the profile are equivalent in the documents. With near field effects in seismic zone 4 (Aa,v=0.4), the seismic coefficients are larger in UBC. In all other seismic zones (Aa,v<0.4), and without near field effects in seismic zone 4, the coefficients are equivalent. Thus, the sections are equivalent. |
| 1.4.4 Seismic Performance Category | The seismic performance category for seismic hazard exposure group III buildings with values of Av ranging from 0.10 to 0.15g was increased from C to D to reduce the risk of collapse in essential service buildings in regions of moderate seismicity. | Table 16-K Occupancy Category | No changes | The seismic hazard exposure group in NEHRP integrates seismic zone and importance of a structure. This is used to categorize buildings for such things as detailing requirements, similar to the use of seismic zones in UBC. Unlike UBC, NEHRP does not base force levels on the importance of a building. Equivalence of the sections must be made on a case by case basis. |
| 1.6 Quality Assurance | Quality assurance provisions now apply to other designated seismic systems in seismic performance category D. | 1701 Special Inspections | No changes | UBC requires inspection of all construction or work for which a permit is required. Since UBC requires special inspection for all seismic zones, it is more stringent. Thus, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.1 Quality Assurance Plan | No Changes | 1702 Structural Observation | An additional condition that requires structural observation of a building was added. The additional condition is for a structure in seismic zone 4, with Na greater than 1, and with a lateral design required for the entire structure. Structural observation is performed by the architect or engineer responsible for the design and is not in lieu of special inspection. | NEHRP states that the person responsible for the design of a designated seismic system shall be responsible for the portion of the quality assurance plan applicable to that system. Since NEHRP does not explicitly require structural observation by an engineer or architect, UBC is more stringent. Thus, the sections are equivalent. |
| 1.6.2.2.1 Special In-spection for Reinforcing Steel | The requirement for periodic special inspection during and upon completion of reinforcing steel placement in intermediate concrete moment frames and concrete shear walls was added. The requirement for periodic special inspection of the placement of steel in reinforced masonry shear walls and ordinary moment frames was deleted. | 1701.5 Types of Work | No changes | Since UBC requires special inspection for placement of all reinforcing steel, UBC is more stringent. Thus, the sections are equivalent. |
| 1.6.2.2.2 Special In-spection for Reinforcing Steel | The requirement for continuous special inspection during the welding of reinforcing steel was defined to pertain to steel resisting flexural and axial forces in intermediate and special moment frames of concrete, and in boundary members of concrete shear walls. | 1701.5 Types of Work | No changes | With exception to the bar type and use, UBC requires special inspection for the welding of all reinforcing steel. Since UBC is more stringent, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.3 Special Inspection of Concrete | The requirement for special inspection during and on completion of the placement of concrete for intermediate and special moment frames and boundary members of concrete shear walls was added. The requirement for periodic special inspection during placement of concrete in reinforced concrete frames and shear walls was deleted. | 1701.5 Types of Work | No changes | With exception to certain foundations, UBC requires special inspection for the placement of all concrete. UBC requires, without exception, continuous special inspection for the placement of concrete in special moment frames. Since UBC is more stringent, the sections are equivalent. |
| 1.6.2.4 Special Inspection of Prestressed Concrete | The requirement for special inspection after the completion of placement of prestressing steel was added. | 1701.5 Types of Work | No changes | Similar to NEHRP, UBC requires special inspection during and after completion of the placement of all prestressing steel. Thus, the sections are equivalent. |
| 1.6.2.6.1 Special Inspection of Structural Steel Welding | An exception to continuous special inspection in lieu of periodic inspection for welds loaded to less than 50 percent of their design strength was added. | 1701.5 Types of Work | No changes | UBC does not make exceptions to continuous special inspection based on the stress level of the weld. Since UBC is more stringent, the sections are equivalent. |
| 1.6.2.6.2 Special Inspection of Structural Steel Bolts | Bolts in connections identified as not being slip-critical or subject to direct tension need not be inspected for bolt tension other than to ensure that the plies of the connected elements have been brought into snug contact. | 1701.5 Types of Work | No Changes | UBC requires the inspection of all high-strength A325 and A490 bolts. Since UBC is more stringent, the sections are equivalent. |
| 1.6.3.1 Testing of Reinforcing Steel | The requirement for a sample at fabricator's plant and the testing of reinforcing steel used in certain applications was deleted. | 1903.1 Tests of Materials | No changes | Since the requirements were deleted in NEHRP, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.3.1.2 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is used to resist earthquake-induced flexural and axial forces in special moment frames and in wall boundary elements of shear walls in buildings of seismic performance category D and E, verify that the requirements of Sec. 21.2.5.1 of Ref. 6-1 have been satisfied. | 1921.2.5.2 Billet Steel A615 Reinforce-ment | This section has not been changed but has been renumbered from 1921.2.5.1. | Since the reference that NEHRP uses is directly incorporated in UBC, the sections are equivalent. |
| 1.6.3.1.3 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is to be welded, verify that chemical tests have been performed to determine weldability in accordance with Sec. 3.5.2 of Ref. 6-1. | 1903.5.2 | No major changes | Since the reference that NEHRP uses is directly incorporated in UBC, the sections are equivalent. |
| 1.6.3.4.3 Testing of Structural Steel | ASTM A435 and ASTM A898 are added criteria on which to judge the acceptability of base metal thicker than 1.5 in. that is subject to through-thickness weld shrinkage strains. | 1703 Non-destructive Testing | No changes | With changes to NEHRP, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.2.4 Analysis Procedures | No changes | 1629.8 Selection of Lateral-Force Procedure<br>1631.6 Time-History Analysis | A simplified static procedure was added which may be used for the following structures of occupancy categories 4 and 5 : 1) Buildings of any occupancy not more than 3 stories in height that use light-frame construction. 2) Other buildings not more than 2 stories in height. Previously these buildings would utilize the static procedure. The requirements for time history analyses were expanded to include the amount and type of time histories that are required. Provisions for non-linear time history analysis were added. | Since NEHRP does not have a simplified static procedure, the buildings that fall under the simplified static procedure of UBC would require a static procedure in NEHRP. As will be addressed, the base shear that results from the simplified static procedure in UBC is larger than the static procedure. Although UBC incorporated a simplified procedure, the loads are more stringent, therefore the sections are equivalent. Since NEHRP does not address time history analysis, UBC is more stringent in requiring it. Therefore, the sections are equivalent. |
| 2.2.5.2.7 Diaphragms | No changes | 1631.2.9 Diaphragms | A new provision limits the length-to-width ratio of a wood subdiaphragm to 2 1/2 : 1. | Since NEHRP does not have provisions for limiting the size of wood subdiaphragms, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.2.6 Combination of Load Effects | Load combinations are referenced to ANSI/ASCE 7-93 which differ from the previously given combinations. In earthquake load combinations, the dead load factor is slightly higher but the live and snow load factors are typically lower. The vertical earthquake loads depend on Ca where they previously depended on Av. The new vertical loads will be less for soil profile A, equivalent for soil type B and in most cases they will be larger for soil types C, D and E. | 1612 Combinations of Loads<br>1630.1.1 Earthquake Loads | The seismic loads in the previous code were at allowable stress levels and the recommended load combinations were based on the combinations of the material used in design. The seismic loads in the new code are at an ultimate strength level. The new code provides load combinations but also refers the user to specific materials chapters. Load combinations to reduce the earthquake loads to allowable stress levels are also provided. The new code includes vertical earthquake loads which are a function of the dead load, Ca, and an importance factor. A reliability/redundancy factor is introduced which increases horizontal earthquake loads for non-redundant structures. | With the change in UBC, both provisions are strength based and the load combinations are equivalent. The horizontal NEHRP earthquake loads does not have a factor similar to the redundancy factor in UBC. The UBC vertical earthquake force has the potential to be larger than NEHRP because UBC includes an importance factor and depending on near field effects, Ca values in UBC could be larger in seismic zone 4. Since UBC earthquake load combinations could lead to a larger force, the sections are equivalent. |
| 2.3.7.1 Story Drift Determination | No changes | 1630.9 Drift | The new code requires calculation of a maximum inelastic response displacement from the static design level response displacement using the ductility factor of the system. All provisions in the code that relate to drift were revised to reflect this change. | Both documents amplify deflections from design level deflections. NEHRP uses a deflection amplification factor and UBC uses a ductility factor. In some cases the amplification for NEHRP is larger than UBC and in some cases it is smaller. The documents may be considered to be essentially equivalent in calculating the drift but the drift limits must also be considered in the comparison (see 2.2.7). |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.4.8 Design Values | No changes | 1631.5.4 Reduction of Elastic Response Parameter for Design | New provisions allow for dynamic forces of a regular structure to be reduced to 80 percent of the static base shear if a site specific response spectrum is used. | NEHRP allows a reduction of the modal base shear to the equivalent lateral force procedure base shear but does not allow a reduction below than. Although UBC allows a greater reduction, based on performance, the sections are judged to be equivalent. This is judged to be the case because with a site specific spectrum, it is assumed that information about the site is known to greater detail. |
| 2.6 Provisions for Seismically Isolated Structures | This is a new section based on the 1994 UBC Appendix Chapter 16, division III. The provisions have been modified to conform to the strength based design approach and nomenclature of the document. | Appendix Chp. 16 Division IV, Earthquake Regulations for Seismic-Isolated Structures | Changes were made to this section to switch form allowable stress to strength based design. Changes in that respect will not be documented. See the following subsections for other major changes. | Since NEHRP was based on an earlier version of UBC, it is assumed that the new UBC is equivalent if not better than the old version. Therefore, the sections are equivalent |
| 2.6.2.3 Seismic Hazard Exposure Group | All portions of the building shall be assigned a Seismic Hazard Exposure Group | 1657.3 Occupancy Categories | No changes | Similar to other provisions, the seismic hazard exposure group in NEHRP integrates seismic zone and importance of a structure. This is used to categorized buildings for such things as detailing requirements, similar to the use of seismic zones in UBC. Unlike UBC, NEHRP does not base force levels on the importance of a building. Equivalence of the sections must be made on a case by case basis. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.6.2.5.2 Equivalent Lateral Force Procedure | The provisions for using the equivalent lateral force procedure are included in this section. | 1657.5.2 Static Analysis | To use the static lateral procedure, the distance to an active fault that a structure is required to be located away from was revised from 15km to 10km. Therefore, the structures that are located between 10 and 15km that previously had to utilize a dynamic analysis can now use a static analysis. | NEHRP allows the static procedure to be used if the structure is located at least 15km from an active fault. NEHRP is more stringent in this requirement since any structure closer than 15km to an active fault must be designed by a dynamic analysis whereas in UBC it is 10km. Although NEHRP is more stringent in requiring a dynamic analysis, since the base shear will be scaled, the sections are equivalent. |
| 2.6.2.5.3.3 Site Specific Design Spectra | The criteria that would require a site specific design spectra analysis is included in this section. | 1657.5.3 Dynamic Analysis | To require a site specific design spectra, the maximum distance that a structure may be located from an active fault was revised from 15km to 10km. The provision that states that structures located in seismic zones 1, 2A or 2B and structures with an isolated period of 3 seconds or more require a site specific spectrum was deleted. | NEHRP is more stringent since there are provisions that state that a site specific design spectra is required if the structure is located within 15km of an active fault or if the isolated period of the building is greater than 3 seconds. Although NEHRP is more stringent in requiring a dynamic analysis, since the base shear will be scaled, the sections are equivalent. |
| 2.6.6.2.8 Inspection and Replacement | Access for inspection and replacement of the isolation system shall be provided. | 1661.2.8 Inspection and Replacement | Additional requirements for inspection were added. | Since NEHRP is equivalent to the 1994 UBC, it does not have the additional requirements set forth in the 1997 UBC. Therefore, the 1997 UBC is more stringent, and the sections are equivalent. |
| 2.6.9.3 Determination of Force Deflection Characteris-tics | This section includes a formula to calculate the effective stiffness of an isolation system. | 1665.3 Determination of Force Deflection Characteris-tics | An additional formula to calculate the effective damping of an isolator unit is included. | The formula to calculate effective stiffness is equivalent in the documents. NEHRP does not include a formula to calculate effective damping. Thus, the sections are essentially equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 2.6.9.4 System Adequacy | This section includes the criteria to judge adequacy in test specimens. | 1665.4 Systems Adequacy | No major changes | UBC requires the specimen to have a positive incremental force-carrying capacity whereas NEHRP does not. UBC requires no greater than 10 percent difference in stiffness whereas NEHRP allows up to 15 percent difference. Therefore, UBC is more stringent and the sections are equivalent. |
| 2.7 Provisions for Nonbuilding Structures | This new section includes requirements to design all self-supporting structures, other than buildings, bridges and dams, that are supported by the earth, that carry gravity loads, and that may be required to resist the effects of an earthquake. | 1634 Nonbuilding Structures | Consistent with other changes, this section was revised to incorporate the change from allowable stress design to ultimate strength design. | The two sections are equivalent in intent. It is apparent that the section in NEHRP was modeled after UBC. Therefore, the sections are equivalent. |
| Appendix to Chapter 2 Passive Energy Dissipation Systems | This section introduces new techniques for incorporating energy dissipation devices into earthquake resistant buildings. This section is included as an appendix because it is intended to be introduction. | | No equivalent section | Although UBC does not have an equivalent section, the appendix in NEHRP is just an introduction to the systems. Therefore, the sections may be considered equivalent. |

# Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

## CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 3.1 General | The requirements for architectural, mechanical, and electrical components have been revised. The exceptions to following the provisions are included. | 1632.1 General | No changes | The intent of the sections are similar, however, the exceptions differ. UBC allows exception for furniture and all equipment weighing less than 400 pounds. NEHRP allows exceptions based on seismic performance category, importance factor, and in one case, weight and location of mounting. UBC is more stringent in most cases because there are no exceptions that are based on seismic zones. Thus, the sections are equivalent. |
| 3.1.4 Seismic Relative Displacement | This new section introduces formulas to calculate the relative displacement that may occur between components. | 1632.4 Relative Motion of Equipment Attachments | No changes | Both documents require consideration of relative motion, although, the method of calculating it differs. NEHRP bases the displacement on the smaller of the actual or the allowable whereas UBC requires calculation based on the actual displacement. Thus, the sections are equivalent. |

## CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 4.2.2 Soil Capacity | No changes | 1809.2 Soil Capacity | A previous provision allowed a one-third stress increase to be exceeded for soils in combination with earthquake when substantiated by geotechnical data. The 1997 code no longer allows this. | Since NEHRP also allows the one-third increase to be exceeded, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 4.4.3 Foundation Ties | The design loads for foundation ties are revised because of the change in seismic coefficients. | 1807.2 Interconnec-tion | No changes | The loads in NEHRP are only larger than UBC when Ca is greater than 0.4. This will occur when Aa=0.4 and soil profile type D exists. With only one exception, the sections are essentially equivalent. |
| | No equivalent section | 1806.2 & 1806.3 Footing Design and Bearing Walls | Consideration for expansive soils is a new requirement. | Since NEHRP does not require consideration for expansive soils, the sections are equivalent. |
| | No equivalent section | 1806.7 Seismic Zones 3 and 4 | This section includes new provisions that require minimum amounts of reinforcement in foundations with stemwalls and slabs on ground with turned down footings. | Since NEHRP does not have similar requirements for minimum amounts of reinforcement, the sections are equivalent. |
| | No equivalent section | 1816.4 Structural Design Procedure for Slabs on Expansive Soils | In the new code, the design procedure for post-tensioned slabs may also be used for stiffening beams or uniform thickness foundations. | Since NEHRP does not have similar provisions, the sections are equivalent. |
| | No equivalent section | 1819 Design of Post-tensioned Slabs on Compressible Soils | This new section includes provisions to design posttensioned slabs on compressible soils. | Since NEHRP does not have similar provisions, the sections are equivalent. |
| | No equivalent tables | Tables 18-III-A-DD | Values of differential swell for velocity of moisture flow for 0.1 and 0.3 inches/month were deleted. | Since NEHRP does not have similar tables, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

### CHAPTER 5: STEEL STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 5.1 Reference Documents | *Seismic Provisions for Structural Steel Buildings* by AISC was added as a reference, and as a result, the length of this chapter was reduced. Part I is based on AISC *LRFD* and Part II is based on AISC *ASD*. Updated versions of *LRFD* by AISC and *Standard Specification, Load Tables and weight Tables for Steel Joists and Joist Girders* are referenced. Another new reference is *Load and Resistance Factor Design Specification for Cold-formed Stainless Steel Structural Members*. | 2206 Adoption<br>Division IV Seismic Provisions for Structural Steel Buildings<br>Division VI Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members<br>Division XI Design Standard for Structural Applications of Steel Cables for Buildings | The 1993 edition of the LRFD was adopted (previously it was 1986) with minimal amendments.<br>The 1992 edition of *Seismic Provisions for Structural Steel Buildings* by AISC with amendments was adopted.<br>The 1991 edition of *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* was adopted with some modifications.<br>The 1995 edition of *Structural Applications of Steel Cables for Buildings* by ASCE was adopted. | Both documents refer to the *LRFD*, *ASD*, *Seismic Provisions for Structural Steel Buildings*, and *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members*.<br>NEHRP adopted *The Criteria for Structural Applications for Steel Cables for Buildings* by AISI 1973 edition.<br>Since the main design specifications are similarly referenced in both documents, the main design intent of the provisions are equivalent. |
| 5.2 Structural Steel Seismic Requirements | The design of structural steel members and connections to resist seismic forces shall be in accordance with ASD and LRFD. | 2204 Design Methods | UBC states that design should be in accordance with LRFD and ASD. | Since both documents refer to the same design manuals, the design criteria are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 5.2.1 Requirements for Special Concentrically Braced Frames | This section includes the modifications to the requirements of *Seismic Provisions for Structural Steel Buildings.* | 2210 Amendments | This section includes the modifications to the requirements of *Seismic Provisions for Structural Steel Buildings.* | NEHRP and UBC made modifications to the requirements for specially concentrically braced frames that are essentially equivalent. UBC contains more modifications than NEHRP because of the difference in variables used. |
| 5.3 Cold-Formed Steel Seismic Requirements | This section references *Seismic Provisions for Structural Steel Buildings* (1992), *Specification for the Design of Cold-Formed Steel Structural Members* (1986), and *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* (1991). Modifications to the references are included. The most notable modification is the use of an earthquake load factor of 1.0 instead of 1.5. | Division VI & VII Specification for Design of Cold-formed Steel Structural Members | This section adopts and modifies *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* (1991) and *Specification for Design of Cold-Formed Steel Structural Members* (1986). | Both documents use the same references. Besides minor differences in modifications that the documents made to the references, the main difference is the use of an earthquake load factor of 1.0 in NEHRP. Since UBC will have higher loads and the reference documents are the same, the sections are equivalent. |
| 5.7 Light-Framed Walls | *Specification for the Design of Cold-Formed Steel Structural Members, Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* and *Specification for the Design of Cold-Formed Stainless Steel Structural Members* are referenced. | Division VIII Lateral Resistance for Steel Stud Wall Systems | This section expands on previous requirements for steel stud walls. New tables are provided that give the lateral resistance of various types of steel stud walls. | The references in NEHRP are referred to in other divisions of the UBC steel chapter. The additional requirements that NEHRP gives are included in UBC. Thus, the sections are equivalent. |
| | The requirements for eccentrically braced frame web stiffeners may be found in section 10.3 of *Seismic Provisions for Structural Steel Buildings.* | 2213.10.9 Web Stiffener Spacing | The spacing of the web stiffener is dependent on link beam rotation. One of the limits was changed from 0.06 to 0.09 radians which makes the requirement for stiffeners less. | With the change in UBC, the limit on link beam rotation is equivalent. Thus, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| | No equivalent provision | 2213.11 Requirements for Special Truss Moment Frames | This new section includes provisions for designing special truss moment frames. | Since NEHRP does not have provisions for special truss moment frames, the sections are equivalent. |

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 6.1 Reference Documents | The revised version of ACI 318-89 is used as a reference. The revised version includes Building Code Requirements for Structural Plain Concrete. | Division II | UBC is in conformance with ACI 318-95 (with modifications). Requirements for Structural Plain Concrete are included. | Since UBC references a later version of ACI 318, UBC is at least equivalent to and possibly more stringent than NEHRP. Thus, the sections are equivalent. |
| 6.1.1.4 | Requirements for precast elements that are part of the lateral-force-resisting system were added. | 1921.2.1.6 | Requirements for precast elements that are part of the lateral-force-resisting system were added. | The provisions in the sections are equivalent. |
| 6.1.1.5 | Requirements for connections of precast concrete elements that emulate the behavior of monolithic reinforced concrete construction were added. | 1921.2.2.5-7 | Requirements for connections of precast concrete elements that emulate the behavior of monolithic reinforced concrete construction were added. | The provisions in the sections are equivalent. |
| 6.1.1.7 | Requirements for strong connections of precast concrete frames were added. | 1921.2.7 | Requirements for strong connections of precast concrete frames were added. | Many provisions are equivalent, however UBC has additional requirements regarding anchorage, splicing, etc. Thus, the sections are equivalent. |
| 6.1.1.12 | This section contains additional requirements for concrete diaphragms. | 1921.6.12 Diaphragms | This section contains additional requirements for concrete diaphragms. | The documents are similar in intent, however, UBC has additional provisions regarding mechanical connectors, prestressing tendons, etc. Thus, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 6.1.1.13 | Provisions for coupling beams were added. | 1921.6.10 Coupling Beams | Provisions for coupling beams were added. | The provisions are equivalent. |
| 6.2.3 Strength Based on Tests | The strength reduction factor for anchors shall be 0.8 when the anchor failure governs in the majority of tests and 0.65 when the concrete failure controls. | 1923.3.1 General<br>1923.3.2 Design Strength in Tension | A phi factor of 0.65 is specified but may be 0.85 when the anchor is attached to or hooked around reinforcing steel or otherwise terminated to effectively transfer forces to the reinforcing steel. | Since the specified phi factor in UBC produces nominal capacities that are equivalent to or less than NEHRP, the sections are equivalent. |
| 6.2.4 Strength Based on Calculations | The formula to calculate the tensile strength governed by concrete failure was revised. Two formulas which depend on the spacing of the anchors are given. | 1923.3 Strength of Anchors | The formulas to calculate the design strength in tension were revised. | The formulas for strength in tension are similar, however NEHRP provides formulas for different conditions of grouping. UBC gives a description of the failure surface which will occur if the anchors are spaced closely. The result would be a formula equivalent to that given in NEHRP. Thus, the sections are equivalent. |
| 6.2.4.3 Combined Tension and Shear | The interaction equations to check the capacity for a combination of tension and shear were revised. The result of the change is less stringent interaction equations. | 1923.3.4 Combined Tension and Shear | One of the interaction equations to check the capacity for a combination of tension and shear was revised. The result of the change is a more stringent interaction equation. | The one equation that is not the same in the documents is more stringent in UBC. Thus, the sections are equivalent. |
| 6.5.1 Ordinary Moment Frames | New requirements for ordinary moment frames with seismic performance category B were added. | 1921.3.2.1 | No changes | The sections are equivalent. |
| 6.7.4 Plain Concrete | A new provision states that structural members of plain concrete are not permitted in buildings assigned to category D or E (with some exceptions). | 1922.10 Seismic Requirements for Plain Concrete | No changes | UBC states that structural members of plain concrete are not permitted in seismic zones 2, 3 and 4 (with some exceptions). The limits that NEHRP and UBC give are equivalent |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| Appendix to Chp. 6 Reinforced Concrete Structural Systems Composed from Interconnected Precast Elements | A new appendix was added to introduce provisions for structural systems composed of precast concrete elements interconnected with dry connections. | 1921.2.1.6 | Requirements for precast elements that are part of the lateral-force-resisting system were added. | Requirements in section 1921.2.1.6 are equivalent to section 6.1.1.4 in NEHRP. Although UBC does not have equivalent provisions, the appendix in NEHRP is just an introduction to the systems. Therefore, the sections may be considered equivalent. |
| | No equivalent provision | 1921.2.1.7 | Requirements for precast gravity systems and its connections were added. | Since NEHRP does not have similar provisions for precast gravity systems, the sections are equivalent. |
| | No equivalent provision | 1921.2.6 | Additional requirements relating to welded splices and mechanically connected reinforcement were added. | Since NEHRP does not have similar requirements, the sections are equivalent. |
| | No equivalent provision | 1921.4.4.8 Ties at Anchor Bolts | Requirements for ties at anchor bolts that are set in the top of a column were added. | Since NEHRP does not have similar requirements, the sections are equivalent. |
| | No equivalent provision | 1921.6.6.2 | The provisions for the effective flange width to design a shear wall were revised. The revision may result in a longer effective flange width. | Since NEHRP does not provisions for effective flange widths, the sections are equivalent. |
| | No equivalent provision | 1921.6.7.3 | Requirements for reinforcement in chords and collectors at splices and anchorage zones were added. | Since NEHRP does not have similar requirement, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| | No equivalent provision | Division VII Unified Design Provisions | A new division was added that includes unified design provisions for reinforced and prestressed concrete flexural and compression members. | Since no equivalent provision exists in NEHRP, the sections are equivalent. |

### CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 7.2 Reference Documents | The reference documents are listed in this section. | Chapter 19 Concrete<br>Chapter 22 Steel | See specific material sections for any changes | The documents that NEHRP and UBC reference are equivalent. |
| 7.5 Composite Members | This section lays out the requirements for structural steel, reinforcing steel and concrete. The requirements refer to the steel and concrete codes. | Chapter 19 Concrete<br>Chapter 22 Steel | See specific material sections for any changes | Since NEHRP and UBC have the same references, the sections are equivalent. |

### CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.1 General | The masonry structure design approach was changed from working stress design to limit states design. | 2102.2 Strength Design | No changes | Since UBC includes provisions for working stress and strength design, the design approaches are equivalent. |
| 8.1.2 Reference Documents | Thirty-five material standard references were added. | 2102.2 Standards of Quality | There were slight changes to the material standards references. | Although both codes have a similar number of references, the references do not necessarily match. Even so, the sections are judged to be essentially equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.3.9 Seismic Performance Category E<br>8A.8.1 Construction Requirements | The requirement for solid grouting of structural masonry that is not part of the seismic resisting system was removed. | 2104.4.4 Hollow-masonry Units<br>2106.1.12.4 Special Provisions for Seismic Zones 3 and 4 | No changes | UBC does not require solid grouting of structural masonry that is not part of the seismic resisting system. UBC requires all head and bed joints to be filled solid with mortar for a distance in from the face of the unit not less than the thickness of the shell. Therefore, the sections are equivalent. |
| 8.3.10 Properties of Materials | The table which contained values of the modulus of elasticity (8.3.10.2) was removed in lieu of calculating the modulus using Eq. 8.3.10.2. The values of modulus of rupture in Table 8.3.10.5.1 were revised. | 2106.2.12.1 Modulus of Elasticity of Masonry<br>2108.2.4.6 Deflection Design | No changes | The formula to calculate the modulus of elasticity of masonry is equivalent in the documents. NEHRP gives values for the modulus of rupture based on whether it is normal or parallel to the bed joints, the type of mortar that is used, and the type of masonry unit. UBC bases the modulus on the compressive strength and the type of masonry unit. NEHRP will typically give lower values for the modulus of rupture, therefore the sections are equivalent. |
| 8.3.12 Plate, Headed and Bent Bar Anchor Bolts | The calculations for the design axial and shear strengths were revised (Eq. 8.3.12.1-1, 8.3.12.1-2, 8.3.12.2-1, 8.3.12.2-2). | 2108.1.5.2 Nominal Anchor Bolt Strength | One of the formulas for the nominal tensile capacity of an anchor bolt was revised. The capacity was reduced since the area of the anchor bolt replaced the area of the pullout cone. Similarly, for nominal shear capacity, the area of the anchor bolt replaced the area of the effective cross-sectional area of reinforcement. | In most cases the anchor bolt nominal strength in NEHRP is larger than UBC. Thus, UBC is more stringent and the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.5.1 General | No changes | 2108.1.3 Required Strength | The load combinations that were previously defined in this section and now are referenced to the load combinations in chapter 16. | Since both codes reference load combinations in the general provisions chapters, the sections are equivalent. |
| 8.6.2 Design Requirements of Reinforced Masonry Members | The critical strain ratio was reduced from 0.003 to 0.002. The critical strain ratio is used to calculate the maximum reinforcement ratio. | 2108.2.3.7 Reinforce-ment<br>2108.2.4.2 Maximum Reinforce-ment | No changes | The maximum reinforcement ratio allowed in UBC is half of the balanced reinforcement ratio. Since the maximum reinforcement allowed in UBC is less than NEHRP, UBC is more stringent. The sections are equivalent. |
| 8.6.3 Design of Plain Unreinforced Masonry Members | The allowable flexural compressive stress for unreinforced masonry in non-seismic applications is now proportional to the strain up to 0.85f'm. The previous version limited this condition to 0.33f'm. | 2107.3.2 Allowable Axial Compressive Stress | No changes | In allowable stress design, UBC places the allowable compressive stress at 0.33f'm. Although the limit in NEHRP is at an ultimate strength level, at an equivalent level, NEHRP would probably still be higher. Thus, UBC is more stringent and the sections are equivalent. |
| 8.7.2 Shear Strength | The 2/3 factor that was applied to shear strength when comparing it to the shear demand was removed. | 2108.2.3.5 Design Strength | No changes | With the change to NEHRP, the codes are equivalent in comparing factored demand to nominal strength. |
| 8.11.2 Confinement of Compressive Stress Zone | The requirement for confinement was changed from a strain limit to the plastic hinge zone regions. The definition of a confined compressive zone was added. | 2108.2.5.6 Boundary Members | No changes | UBC requires boundary members to be provided when the strain exceeds 0.0015. Although the change in NEHRP provides a more qualitative definition, the intent is similar and the sections are essentially equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.11.3 Flanged Shear Walls | A requirement was added that states that solid units shall be laid in running bond and 50% of the masonry units at wall intersections shall be interlocked. The effective width of flange in compression was changed from 1/6 of the wall height to 9 times the thickness of the web. The effective width of flange in tension was changed from 1/3 of the wall height to 3/4 of the wall height. | 2106.2.6 Effective Width of Intersecting Walls | No changes | UBC allows for the effective flange width to be 6 times the thickness of the intersected wall on each side. Unlike NEHRP, there is no distinction of the width for tension versus compression. Since the effective flange width in UBC is smaller, UBC is more stringent. Thus, the sections are equivalent. |
| 8.12 Wall Frames | The requirement of where plastic hinges shall be formed was removed. | | No equivalent provision | Since NEHRP removed the provision, the sections are equivalent. |
| 8.12.4 Reinforce-ment | A new restriction requires that actual yield strength shall not exceed 1.5 times the nominal yield strength. | 2108.2.6.2.4 Reinforce-ment | No changes | UBC states that the actual yield strength shall not exceed the 1.3 times the specified yield strength, whereas it is 1.5 in NEHRP. Thus UBC is more stringent and the sections are equivalent. |
| 8.12.5 Wall Frame Beams | An additional restriction that the reinforcement ratio shall be less than 0.15f'm/fy was added. The maximum spacing of transverse reinforcement was increased from 1/4 of the beam depth to 1/2 of the beam depth. | 2108.2.6.2.5 Flexural Members (beams) | No changes | The maximum reinforcement in beams in the documents is equivalent. The maximum spacing of transverse reinforcement is also equivalent. |
| 8.12.6 Wall Frame Columns | The limit of factored axial compression force was changed from 0.30Anf'm to 0.15Anf'm. The limit of minimum column dimension was decreased from 32 inches to 24 inches. | 2108.2.6.1.2 Dimensional Limits<br>2108.2.6.2.7 Pier Design Forces | No changes | The limit on factored axial compression force is equivalent. The minimum nominal depth of a pier in UBC is two full units or 32 inches, whereas it is 24 inches in NEHRP. There UBC is more stringent and the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 8.12.7 Wall Frame Beam-Column Intersection | The definition of the dimension of the beam-column intersection was changed from a multiple of the bar diameters to Eq. 8.12.7.1-1 and Eq. 8.12.7.1-2. A restriction that the shear stress shall not exceed 7 roots f'm was added. | 2108.2.6.2.9 Joints | No changes | The formulas for the dimension of the pier are equivalent. The formula in NEHRP will give a beam depth that is over 2 times larger than UBC. UBC is more stringent since it will produce a smaller joint. Therefore the sections are equivalent. Similar to NEHRP, UBC has a provision to limit the shear strength to 7 roots f'm. |

### CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 9.1 Reference Documents | Several reference documents have new editions and there are a few new references. | 2303 Standards of Quality<br>2316.1 Adoption and Scope | Standards are referenced for various aspects of wood design. The 1991 edition of the NDS is adopted for the allowable stress design of wood. In the previous code, NDS was incorporated but not specifically adopted. | Since the reference to 1991 NDS is consistent in both documents, design specifications are essentially equivalent. Although some of the material references are similar, for the most part the references in the documents are not the same. Even so, the sections are judged to be essentially equivalent. |
| 9.2 Strength of Members and Connections | The factor to multiply the allowable working stress has been increased from 2.0 to 2.16. The phi factors have been revised. The phi factor was reduced for members in flexure with compression. The categories of connectors have been revised. The phi factor was reduced for shear on diaphragms and shear walls. In general, with the increase in capacity and decrease in phi factor, the resulting nominal capacity is lower. | 2301.2.1 Allowable Stress Design | No changes | UBC uses allowable stress design for wood. Using the strength increase and phi factors in NEHRP, the strength is increased more than the value of the load factors. Therefore, since NEHRP capacities are higher relative to the demand, the sections are equivalent. |

## Table 2B: Changed Provisions in UBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 UBC | Changes | Comments |
|---|---|---|---|---|
| 9.10.2.1 Wall Anchorage | No changes | 1806.6 Foundation Plates or Sills | The size of steel bolt required was increased for seismic zone 4. | The bolt size required in seismic zone 4 in UBC is larger than NEHRP. Thus, the sections are equivalent. |
| | No equivalent provision | 2315.1 General | The height of a shear wall is defined and guidelines for designing a shear wall with openings are included. | NEHRP does not specifically address the design of a shear wall with openings. Thus, the sections are equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

### CHAPTER 1: GENERAL PROVISIONS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 1.2 Scope | This section lists structures that are exceptions to seismic design provisions. Exceptions for one and two family dwellings that were previously dependent on Av, were revised to depend on a new coefficient Ca. | 1607.1 General | This section allows the loads to be determined from this section or ASCE 7-95. This change was incorporated because SBC did not adopt the Ca and Cv factors of the 1994 NEHRP or ASCE 7-95. The 1997 SBC still uses the Aa and Av factors from the 1991 NEHRP. | The 1997 SBC deviates significantly here due to the fact it did not adopt the Ca and Cv factors used in the 1994 NEHRP. Thus, NEHRP is more stringent and the sections are not equivalent. |
| 1.4.2 Seismic Coefficients | Six new soil profile types are defined in this section where previously there were 4. Seismic coefficients Ca and Cv, which depend on soil profile and seismic zone, are introduced in this section. Ca and Cv replace AaS and Av in the 1991 provisions. All provisions that were previously related to Av and Aa were revised to reflect the new coefficients. | 1607.3.1 Site Coefficient | No changes | Since SBC did not adopt the changes made to NEHRP, using NEHRP will result in higher seismic forces for soft soils, especially in regions of low seismicity. Thus, NEHRP is more stringent and the sections are not equivalent for soft soils. |
| 1.4.4 Seismic Performance Category | The seismic performance category for seismic hazard exposure group III buildings with values of Av ranging from 0.10 to 0.15g was increased from C to D to reduce the risk of collapse in essential service buildings in regions of moderate seismicity. | 1607.1.7 Seismic Performance Category | No changes | Since SBC did not adopt the changes made to NEHRP, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 1.6 Quality Assurance | Quality assurance provisions now apply to other designated seismic systems in seismic performance category D. | 1708 Seismic Inspections and Testing | No changes | For other designated seismic systems, SBC only requires inspection in Category E. Thus, NEHRP is more stringent and the sections are judged not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.1 Foundation Special Inspection | The requirement for continuous special inspection for placement of concrete was added. The requirement for continuous special inspection for construction of drilled piles and caissons was changed to periodic inspection. The requirement for periodic inspection for placement of reinforcing steel was added. | 1780.7 Foundations | No changes | SBC only requires that inspection is required. Thus, by requiring continuous inspection for placement of concrete, NEHRP is more stringent and the sections are judged not equivalent. |
| 1.6.2.4 Special Inspection of Prestressed Concrete | The requirement for special inspection after the completion of placement of prestressing steel was added. | 1708.4 Reinforced Concrete | No changes | Since SBC did not make this modification, NEHRP is more stringent. Thus, the sections are judged not equivalent. |
| 1.6.2.6.1 Special Inspection of Structural Steel Welding | An exception to continuous special inspection in lieu of periodic inspection for welds loaded to less than 50 percent of their design strength was added. | 1708.2 Structural Steel Welding | No changes | Inspection of structural steel welding in SBC consists of ultrasonic testing. However, the testing is required on certain elements, not for all welding. Thus, NEHRP is more stringent and the sections are judged not equivalent. |
| 1.6.2.8 Special Inspection of Architectural Components | The criteria for requiring special inspection changed from the performance criteria factor P, which depends on seismic hazard exposure group and the item to be braced, to the seismic performance category, which depends on Av and seismic hazard exposure group. Exceptions to periodic special inspection were added and additional items requiring inspection was added. | 1708.8 Wall Panels and Veneers | No changes | Since SBC only requires inspection in seismic performance category E and has retained the performance criteria P, NEHRP is more stringent and the sections are judged not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.9 Special Inspection of Mechanical and Electrical Components | The criteria for requiring special inspection changed from performance criteria P to seismic performance category (see above). The items requiring special inspection were revised. | 1708.9 Mechanical and Electrical Components | No changes | Since SBC only requires inspection in seismic performance category E and has retained the performance criteria P, NEHRP is more stringent and the sections are judged not equivalent. |

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 2.2.5.1.2 Anchorage of Concrete or Masonry Walls | Although there were no changes in this section, the formula to calculate the anchorage force in section 3.1.3 was revised. | 1607.3.6.1.2 Concrete or Masonry Wall Anchorage | No changes | Since SBC did not adopt the change to the anchorage force, the change in NEHRP will result in a higher anchorage force. Thus, NEHRP is more stringent and the sections are not equivalent. |
| 2.2.6 Combination of Load Effects | Load combinations are referenced to ANSI/ASCE 7-93 which differ from the previously given combinations. In earthquake load combinations, the dead load factor is slightly higher but the live and snow load factors are typically lower. The vertical earthquake loads depend on Ca where they previously depended on Av. The new vertical loads will be less for soil profile A, equivalent for soil type B and in most cases they will be larger for soil types C, D and E. | | No equivalent section | Since SBC has no provisions regarding combination of load effects, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 2.2.7 Deflection and Drift Limits | The category for single story buildings in the allowable drift limit table was deleted. Previously there was no limit on the allowable drift for single story buildings in seismic hazard exposure group I. New stringent allowable drift limits have been specified for masonry buildings. | Table 1607.3.8 Allowable Story Drift | No changes | By not incorporating the changes made to NEHRP, masonry shear walls designed to the 1997 SBC are allowed a greater drift. Thus, NEHRP is more stringent and the two tables are judged not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 2.3.2.1 Calculation of Seismic Response Coefficient | In calculating Cs, the seismic response coefficient, Cv replaces AvS and Ca replaces Aa in the equations. Using these new coefficients, the base shear is lowered for structures on rock but is increased for structures on soft soils. The base shear of a structure is V=CsW. | 1607.4.1.1 Calculation of Seismic Response Coefficient | No changes | Since SBC did not adopt the change to the seismic response coefficient, NEHRP results in higher seismic forces for buildings on soft soils. Thus, NEHRP is more stringent and the sections are not equivalent. |
| 2.6 Provisions for Seismically Isolated Structures | This is a new section based on the 1994 UBC Appendix Chapter 16, division III. The provisions have been modified to conform to the strength based design approach and nomenclature of the document. | | No equivalent section | SBC has no specific provisions for seismically isolated structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |
| 2.6.2.3 Seismic Hazard Exposure Group | All portions of the building shall be assigned a Seismic Hazard Exposure Group | | No equivalent section | SBC has no specific provisions for seismically isolated structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |
| 2.6.2.5.2 Equivalent Lateral Force Procedure | The provisions for using the equivalent lateral force procedure are included in this section. | | No equivalent section | SBC has no specific provisions for seismically isolated structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 2.6.2.5.3.3 Site Specific Design Spectra | The criteria that would require a site specific design spectra analysis is included in this section. | | No equivalent section | SBC has no specific provisions for seismically isolated structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |
| 2.6.6.2.8 Inspection and Replacement | Access for inspection and replacement of the isolation system shall be provided. | | No equivalent section | SBC has no specific provisions for seismically isolated structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |
| 2.6.9.3 Determination of Force Deflection Characteris-tics | This section includes a formula to calculate the effective stiffness of an isolation system. | | No equivalent section | SBC has no specific provisions for seismically isolated structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |
| 2.6.9.4 System Adequacy | This section includes the criteria to judge adequacy in test specimens. | | No equivalent section | SBC has no specific provisions for seismically isolated structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 2.7 Provisions for Nonbuilding Structures | This new section includes requirements to design all self-supporting structures, other than buildings, bridges and dams, that are supported by the earth, that carry gravity loads, and that may be required to resist the effects of an earthquake. | | No equivalent section | SBC has no specific provisions for nonbuilding structures. While SBC does not prohibit this type of design, it is silent on the approach to take to design a seismically isolated structure. Therefore, NEHRP is more restrictive and the sections are not equivalent. |

### CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 3.1 General | The requirements for architectural, mechanical, and electrical components have been revised. The exceptions to following the provisions are included. | 1607.6 Architectural, Mechanical, and Electrical Components and Systems | No changes | Since SBC did not revise this section to include the new provisions, NEHRP is more stringent and the sections are not equivalent. |
| 3.1.3 Seismic Forces | Previously, lateral force calculations for architectural and mechanical/electrical equipment were separated. In the new provisions, general formulas for all equipment are provided. The formulas depend on Ca, importance factor of the equipment, component amplification, response factors, and vertical location of the equipment in the building. | 1607.6.3 Architectural Component Design<br>1607.6.4 Mechanical, Electrical Component and System Design | This section added an exception to seismic forces for architectural component design of storage racks. The formulas used are still from the 1991 NEHRP. | Since SBC did not revise the formulas, the NEHRP formulas will result in higher seismic forces for nonstructural components. Thus, NEHRP is more stringent and the sections are not equivalent. |
| 3.1.4 Seismic Relative Displacement | This new section introduces formulas to calculate the relative displacement that may occur between components. | | No equivalent section | Since SBC has no provision, NEHRP is more stringent. Thus, the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 3.1.5 Component Importance Factor | New importance factors are introduced which depend on the severity of failure of the component. | Table 1607.6.3<br>Table 1607.6.4A | No changes | Since SBC did not revise this section, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 3.2.6 Suspended Ceilings | This new section outlines additional requirements for bracing suspended ceilings.<br>Design and construction references and minimum clearances are among the additional requirements. | 1607.6.3.3 Ceilings | No changes | Since SBC did not revise this section, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 3.2.7 Access Floors | This new section outlines additional requirements for bracing access floors. The weight used to calculate loads and the requirements for special access floors are included. | | No equivalent section | Since SBC has no provision, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 3.2.9 Steel Storage Racks | This new section outlines additional requirements for bracing steel storage racks. The weight used to calculate loads and the response factor to design storage racks is included. | | No equivalent section | Since SBC has no provision, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 3.3 Mechanical and Electrical Components | Extensive requirements for bracing various mechanical and electrical components such as piping, elevators, and storage tanks are provided. | 1607.6.4 Mechanical, Electrical Component and System Design | No changes | Since SBC did not revise this section, NEHRP is more stringent. Thus, the sections are not equivalent. |

# Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

## CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 4.4.3 Foundation Ties | The design loads for foundation ties are revised because of the change in seismic coefficients. | 1804.5 Footing Seismic Ties | No changes | The loads in NEHRP are larger when Ca is greater than 0.4, which occurs in regions of high seismicity with soft soils. Since no change was made to SBC, NEHRP is more stringent under these conditions. Thus, the sections are not equivalent in high seismic zones on soft soils. |

## CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 6.1.1.5 | Requirements for connections of precast concrete elements that emulate the behavior of monolithic reinforced concrete construction were added. | 1912.1.1 Modifications to ACI 318-95 | No equivalent modification | Since SBC does not have this modification, the modification results in NEHRP being more stringent. Thus, the sections are not equivalent. |
| 6.1.1.7 | Requirements for strong connections of precast concrete frames were added. | 1912.1.1 Modifications to ACI 318-95 | No equivalent modification | Since SBC does not have this modification, the modification results in NEHRP being more stringent. Thus, the sections are not equivalent. |
| 6.1.1.8 | This section includes provisions for calculating the probable capacities of structural elements in precast concrete frames. | 1912.1.1 Modifications to ACI 318-95 | No equivalent modification | Since SBC does not have this modification, the modification results in NEHRP being more stringent. Thus, the sections are not equivalent. |
| 6.1.1.12 | This section contains additional requirements for concrete diaphragms. | 1912.1.1 Modifications to ACI 318-95 | No equivalent modification | Since SBC does not have this modification, the modification results in NEHRP being more stringent. Thus, the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 6.2.2 Strength of Anchors | A provision was added that states that anchors shall be detailed so that the connection failure is initiated by the failure of the anchor steel rather than by the failure of the surrounding concrete. | 1914.1.3 Strength of Anchors | No changes | SBC does not distinguish the strength of anchors due to failure mode. NEHRP will provide a ductility failure mode, while SBC may not. Thus, the sections are not equivalent. |
| 6.2.3 Strength Based on Tests | The strength reduction factor for anchors shall be 0.8 when the anchor failure governs in the majority of tests and 0.65 when the concrete failure controls. | 1914.1.3 Strength of Anchors | No changes | Since SBC does not distinguish the strength of anchors due to failure mode, there are no strength reducing factors. Thus NEHRP is more stringent and the sections are not equivalent. |
| 6.2.4.3 Combined Tension and Shear | The interaction equations to check the capacity for a combination of tension and shear were revised. The result of the change is less stringent interaction equations. | 1914.1.6 Combined Tension and Shear | No changes | SBC was more stringent than the previous version of NEHRP. However, with the modifications to NEHRP, SBC only has two of the four equations in NEHRP. Thus, NEHRP is more stringent and the sections are not equivalent. |
| 6.5.2 Moment Frames | A new provision was added that states that moment frames on soil profile type E or F with seismic performance category B shall be an intermediate moment frame. | | No equivalent section | Since SBC has no equivalent section, NEHRP is more stringent. Thus, the sections are not equivalent for seismic performance category B moment frames on soil types E and F. |

# Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

## CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| Chapter 7 Composite Steel and Concrete Structure Design Requirements | This new chapter presents design and detailing requirements for composite structures that are expected to provide structural toughness, ductility, strength, and stiffness equivalent to comparable concrete and steel structures. | | No equivalent section | There is no equivalent section regarding composite design in SBC. In addition, although not prohibiting composite design, SBC is silent on any specific approach to take in designing a structure using a composite lateral-force-resisting system. Therefore, NEHRP is more stringent and the sections are not equivalent. |
| 7.2 Reference Documents | The reference documents are listed in this section. | | No equivalent section | Since there is no equivalent section regarding composite design in SBC, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.4 Composite Systems | Requirements to design composite systems (partially restrained frames, ordinary moment frames, special moment frames, concentrically braced frames, eccentrically braced frames, reinforced concrete walls composite with steel elements and composite shear walls) are in this section. The section outlines the design requirements for individual elements of the system. | | No equivalent section | Since there is no equivalent section regarding composite design in SBC, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.5 Composite Members | This section lays out the requirements for structural steel, reinforcing steel and concrete. The requirements refer to the steel and concrete codes. | | No equivalent section | Since there is no equivalent section regarding composite design in SBC, NEHRP is more stringent. Thus, the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 7.5.2 Composite Beams | Additional requirements for special moment frames are given as follows. A maximum distance from the maximum concrete compression fiber to the plastic neutral axis is given. Compression elements that are fully encased by a reinforced concrete cover (min 2") do not need to meet the width-thickness ratio provided that concrete is confined by hoop reinforcement in regions where plastic hinges are expected to occur. | | No equivalent section | Since there is no equivalent section regarding composite design in SBC, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.5.3 Encased Composite Columns | This section references LRFD for the design of encased composite columns. Additional requirements for seismic performance category C, D and E are given. Most of the additional requirements are related to concrete reinforcing. | | No equivalent section | Since there is no equivalent section regarding composite design in SBC, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.5.4 Filled Composite Columns | This section outlines the requirements for filled composite columns. LRFD is referenced and additional requirements are given for seismic performance categories D and E. | | No equivalent section | Since there is no equivalent section regarding composite design in SBC, NEHRP is more stringent. Thus, the sections are not equivalent. |
| 7.6 Composite Connections | This section includes requirements for connections in structures with composite or dual steel-concrete systems where seismic loads are transferred. | | No equivalent section | Since there is no equivalent section regarding composite design in SBC, NEHRP is more stringent. Thus, the sections are not equivalent. |

# Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

## CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 8.1 General | The masonry structure design approach was changed from working stress design to limit states design. | 2115.2 General | This section incorporates ACI 530/ASCE 5/TMS 402-95 in its entirety. Modifications to this reference were removed in regards to seismic design. | ACI 530/ASCE 5/TMS 402-95 did incorporate strength design for the seismic provisions. Therefore, the methodology approach is the same. However, rather than develop a separate set of strength design provisions, the standard takes the existing working stress design methodology and uses load factors, phi factors, and a 3.325 increase of allowable working stress values. The detailing provisions in the standard essentially remain the same. In comparing ACI 530 and NEHRP, the formulas to calculate strength capacities appear to be equivalent, although NEHRP tends to be a bit more restrictive. In the detailing provisions, similar checks are required in both documents. However, NEHRP is more restrictive with the parameters it sets, such as maximum size of reinforcement, bundling of reinforcing bars, and hook development lengths in tension. Based on the comparison of ACI 530 and NEHRP, NEHRP appears to be more stringent. Thus, SBC and NEHRP are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 8.1.2 Reference Documents | Thirty-five material standard references were added. | 3502 Referenced Standards | Eleven of the standards referenced in NEHRP were not referenced in SBC. However, most of those not referenced were testing standards or material standards not related to masonry. | Because SBC does not reference all of the standards in NEHRP, the sections are not equivalent. However, material standards are not that critical in terms of equivalence. |
| 8.3.8 Seismic Performance Category D | The required roughened surface exposure for concrete placement next to masonry that is not designed with a separation joint was increased from 1/16" to 1/8". | 2115.7 Seismic Performance Category D | No changes | Neither SBC nor ACI 530 have this requirement. Thus, NEHRP is more stringent and the sections are judged not equivalent. |
| 8.4.3 Placement Limits for Reinforce-ment | Bundling of bars is no longer allowed. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 allows the use of bundled bars. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.4.5 Devel-opment of Reinforce-ment | The calculation of embedment length (Eq. 8.4.5.2) was modified. A requirement for 6 inches of minimum embedment length for wire was added. The calculation of embedment length for hooks (Eq. 8.4.5.4.2) was modified. Lap splices are no longer allowed in plastic hinge zones. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | Due to the equation parameters, a direct comparison was not possible. However, the equation in ACI 530/ASCE 5/TMS 402-95 only considers the diameter of the bar and the strength of steel. The equations in NEHRP also take into account clear cover and strength of masonry. Based on this, the NEHRP may be considered more stringent and the sections are not equivalent. |
| 8.5.4 Deformation Requirements | This section was rewritten to be consistent with the deformation criteria set forth in Chapter 2. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain deformation provisions, only strength provisions. Thus, NEHRP is more restrictive and the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 8.6.2 Design Requirements of Reinforced Masonry Members | The critical strain ratio was reduced from 0.003 to 0.002. The critical strain ratio is used to calculate the maximum reinforcement ratio. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not define a critical strain ratio. Thus, NEHRP is more stringent and the sections are not equivalent. |
| 8.7.3 Design of Reinforced Masonry Members | The equations to calculate shear strength in both the masonry and reinforcing steel were modified (Eq. 8.7.3.2-1, 8.7.3.3). | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses one equation for calculating the shear capacity, independent of the steel reinforcement provided. NEHRP uses separate equations for calculating shear capacities of masonry and steel. Since NEHRP is the more accurate of the two methods, is may be considered more stringent. Thus, the sections are not equivalent. |
| 8.11.2 Confinement of Compressive Stress Zone | The requirement for confinement was changed from a strain limit to the plastic hinge zone regions. The definition of a confined compressive zone was added. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for confinement of the compressive stress zone. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.11.3 Flanged Shear Walls | A requirement was added that states that solid units shall be laid in running bond and 50% of the masonry units at wall intersections shall be interlocked. The effective width of flange in compression was changed from 1/6 of the wall height to 9 times the thickness of the web. The effective width of flange in tension was changed from 1/3 of the wall height to 3/4 of the wall height. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for flanged shear walls. Thus, NEHRP is more restrictive and the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 8.12 Wall Frames | The requirement of where plastic hinges shall be formed was removed. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frames. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.4 Reinforce-ment | A new restriction requires that actual yield strength shall not exceed 1.5 times the nominal yield strength. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame reinforcement. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.5 Wall Frame Beams | An additional restriction that the reinforcement ratio shall be less than 0.15f'm/fy was added. The maximum spacing of transverse reinforcement was increased from 1/4 of the beam depth to 1/2 of the beam depth. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame beams. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.6 Wall Frame Columns | The limit of factored axial compression force was changed from 0.30Anf'm to 0.15Anf'm. The limit of minimum column dimension was decreased from 32 inches to 24 inches. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame columns. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.7 Wall Frame Beam-Column Intersection | The definition of the dimension of the beam-column intersection was changed from a multiple of the bar diameters to Eq. 8.12.7.1-1 and Eq. 8.12.7.1-2. A restriction that the shear stress shall not exceed 7 roots f'm was added. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame beam-column intersections. Thus, NEHRP is more restrictive and the sections are not equivalent. |

## Table 3A: Changed Provisions in SBC and NEHRP Judged Not Equivalent

### CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 9.9.1.2 Shear Panels Sheathed with Other Sheet Materials | Previously, light framed walls sheathed with lath and plaster, gypsum sheathing boards, gypsum wallboard, or fiberboard sheets could be used to resist earthquake forces. Except in conventional construction, new provisions do not allow sheet materials other than structural-use materials to be part of the seismic force resisting system. | 2308.2.4 Fiberboard Sheathing<br>Table 2308.2.4 Allowable Working Stress Shears<br>Table 2306.1 Fastening Schedule | The section and tables now differentiate between regular fiberboard and structural fiberboard. | Since NEHRP does not allow the use of fiberboard sheets except in conventional construction, it is more stringent than SBC. Thus, the two section are judged not equivalent. |
| 9.9.1.2 Shear Panels Sheathed with Other Sheet Materials | Previously, light framed walls sheathed with lath and plaster, gypsum sheathing boards, gypsum wallboard, or fiberboard sheets could be used to resist earthquake forces. Except in conventional construction, new provisions do not allow sheet materials other than structural-use materials to be part of the seismic force resisting system. | 2501.0 Gypsum Board and Plaster | SBC allows the use of gypsum board and plaster to resist seismic forces in wood-framed buildings. | Since the 1994 NEHRP does not allow the use of gypsum board and similar materials to resist seismic forces at all, it is more stringent. Thus, the sections are not equivalent for wood-framed buildings. |
| | No equivalent section | 2308.2.3<br>Alternate Braced<br>Wall Panels | This section was added to allow alternate braced wall panels for certain conditions. | The SBC section is a relaxation of the wall bracing requirements for certain conditions. Since NEHRP has no alternate provisions, it is more stringent. Thus, the sections are judged not equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| CHAPTER 1: GENERAL PROVISIONS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **1997 SBC** | **Changes** | **Comments** |
| 1.6.2.2.1 Special Inspection for Reinforcing Steel | The requirement for periodic special inspection during and upon completion of reinforcing steel placement in intermediate concrete moment frames and concrete shear walls was added. The requirement for periodic special inspection of the placement of steel in reinforced masonry shear walls and ordinary moment frames was deleted. | 1708.4 Reinforced Concrete | No changes | Since SBC already has the modifications NEHRP has made, the sections are judged equivalent. |
| 1.6.2.2.2 Special Inspection for Reinforcing Steel | The requirement for continuous special inspection during the welding of reinforcing steel was defined to pertain to steel resisting flexural and axial forces in intermediate and special moment frames of concrete, and in boundary members of concrete shear walls. | 1708.4 Reinforced Concrete | No changes | SBC requires inspection of welding of all reinforcing in accordance with ASTM A706. Thus, SBC is more stringent and the sections are judged equivalent. |
| 1.6.2.3 Special Inspection of Concrete | The requirement for special inspection during and on completion of the placement of concrete for intermediate and special moment frames and boundary members of concrete shear walls was added. The requirement for periodic special inspection during placement of concrete in reinforced concrete frames and shear walls was deleted. | 1708.4 Reinforced Concrete | No changes | By not making the modifications NEHRP incorporated, SBC is now actually more stringent. Thus, the sections are judged equivalent. |
| 1.6.2.6.2 Special Inspection of Structural Steel Bolts | Bolts in connections identified as not being slip-critical or subject to direct tension need not be inspected for bolt tension other than to ensure that the plies of the connected elements have been brought into snug contact. | 1708.3 High-Strength Bolts | No changes | SBC requires that all high-strength bolts require inspection in accordance with AISC. Thus, SBC is more stringent and the sections are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.7.1 Special Inspection of Structural Wood | The requirement for continuous special inspection during field gluing operations was defined to be for elements of the seismic force resisting system. | 1708.6 Wood Construction | No changes | Since SBC has the modification that NEHRP has made, the sections are judged equivalent. |
| 1.6.2.7.2 Special Inspection of Structural Wood | The requirement for periodic special inspection for nailing, bolting, anchoring, and other fastening was defined to pertain to all seismic components. | 1708.6 Wood Construction | No changes | Since SBC has the modification that NEHRP has made, the sections are judged equivalent. |
| 1.6.3.1 Testing of Reinforcing Steel | The requirement for a sample at fabricator's plant and the testing of reinforcing steel used in certain applications was deleted. | 1706 Test Procedure | No changes | SBC does not specify testing methods directly. Rather, they accept any nationally recognized organization in the business of establishing test procedures as criteria for testing of materials. Thus, by rationale, SBC and NEHRP are judged equivalent. |
| 1.6.3.1.1 Testing of Reinforcing Steel | The requirement to examine the certified mill test reports for each shipment of reinforcing steel was defined to pertain to steel used to resist flexural and axial forces in reinforced concrete intermediate and special moment frames and boundary members of reinforced concrete or reinforced masonry shear walls. | 1706 Test Procedure | No changes | SBC does not specify testing methods directly. Rather, they accept any nationally recognized organization in the business of establishing test procedures as criteria for testing of materials. Thus, by rationale, SBC and NEHRP are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 1.6.3.1.2 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is used to resist earthquake-induced flexural and axial forces in special moment frames and in wall boundary elements of shear walls in buildings of seismic performance category D and E, verify that the requirements of Sec. 21.2.5.1 of Ref. 6-1 have been satisfied. | 1706 Test Procedure | No changes | SBC does not specify testing methods directly. Rather, they accept any nationally recognized organization in the business of establishing test procedures as criteria for testing of materials. Thus, by rationale, SBC and NEHRP are judged equivalent. |
| 1.6.3.1.3 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is to be welded, verify that chemical tests have been performed to determine weldability in accordance with Sec. 3.5.2 of Ref. 6-1. | 1706 Test Procedure | No changes | SBC does not specify testing methods directly. Rather, they accept any nationally recognized organization in the business of establishing test procedures as criteria for testing of materials. Thus, by rationale, SBC and NEHRP are judged equivalent. |
| 1.6.3.4.3 Testing of Structural Steel | ASTM A435 and ASTM A898 are added criteria on which to judge the acceptability of base metal thicker than 1.5 in. that is subject to through-thickness weld shrinkage strains. | 1706 Test Procedure | No changes | SBC does not specify testing methods directly. Rather, they accept any nationally recognized organization in the business of establishing test procedures as criteria for testing of materials. Thus, by rationale, SBC and NEHRP are judged equivalent. |
| | No equivalent section | 1709 Inspection of Spray-Applied Fire Resistant Materials | Cohesion/adhesion test and acceptance criteria were added to this section. | Since NEHRP has no provisions, SBC is more stringent. Thus, the sections are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 2.2.2 Structural Framing Systems | New building frame systems, particularly relating to composite systems, were added. R and Cd values for ordinary moment frames of reinforced concrete and intermediate moment frames of reinforced concrete were increased. | 1607.3.3 Structural Framing Systems | No changes | SBC does not have any provisions related to the design of composite systems. In addition, although SBC does not prohibit composite design, there are no provisions to design a composite structure by rational analysis. Thus, the sections are not equivalent when dealing with composite structures. In other structures, however, SBC has an R value equal to or less than NEHRP's values. Thus, the sections are equivalent. |
| 2.3.2 Seismic Base Shear | The statement regarding the amount of snow load to include in the dead load weight was deleted. | 1607.4.1 Seismic Base Shear | No changes | Since SBC did not adopt the change to NEHRP, it is more restrictive than NEHRP. Thus, the sections are equivalent. |
| Appendix to Chapter 2 Passive Energy Dissipation Systems | This section introduces new techniques for incorporating energy dissipation devices into earthquake resistant buildings. This section is included as an appendix because it is intended to be introduction. | | No equivalent section | Although SBC does not have an equivalent section, the appendix in NEHRP is just an introduction to the systems. Therefore, the sections may be considered equivalent. |

### CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 4.5.2 Foundation Ties | Individual spread footings are required to have ties only for soft soil, whereas previously ties were required for conditions when the soil is anything other than rock. | 1804.5 Footing Seismic Ties | No changes | By not changing this provision, the 1997 SBC is more restrictive than the 1994 NEHRP. Thus, the sections are equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| | No equivalent section | 1804.6 Foundation Walls | This section on Foundation Walls was rewritten, incorporating ACI 530/ASCE 5/TMS 402-95 and ACI 318-95. Minimum thickness tables were added for walls that do not need to be designed by ACI 530/SCE 5/TMS 402-95 or ACI 318-95. | Since the 1994 NEHRP has no provisions regarding foundation walls, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1804.2.1 Plain Concrete, Masonry, or Timber Footings | This section now provides methods for determining undisturbed or compact soils, which was a previous requirement. | Since the 1994 NEHRP has no provisions regarding soil test procedures, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |

### CHAPTER 5: STEEL STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 5.1 Reference Documents | *Seismic Provisions for Structural Steel Buildings* by AISC was added as a reference, and as a result, the length of this chapter was reduced. Part I is based on AISC *LRFD* and Part II is based on AISC *ASD*. Updated versions of *LRFD* by AISC and *Standard Specification, Load Tables and weight Tables for Steel Joists and Joist Girders* are referenced. Another new reference is *Load and Resistance Factor Design Specification for Cold-formed Stainless Steel Structural Members*. | 3502 Referenced Standards | One of the eight references in NEHRP were not included in SBC having to do with steel joists. | Since both codes reference the same essential standards, the sections are judged equivalent. |
| 5.1 Reference Documents | NEHRP uses the AISI reference for Steel Cables (1973 Edition). | 2206 Structural Steel Cables | ASCE took the AISI reference on Steel Cables and adopted it. This section now refers to ASCE 19-95 rather than AISI. | Since both codes use the same document and SBC uses the more current edition, the sections are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 5.2 Structural Steel Seismic Requirements | The design of structural steel members and connections to resist seismic forces shall be in accordance with ASD and LRFD. | 2203.1 General | No changes | Since SBC already uses ASD and LRFD, the sections are equivalent. |
| 5.2.1 Requirements for Special Concentrically Braced Frames | This section includes the modifications to the requirements of *Seismic Provisions for Structural Steel Buildings*. | 2203.2 Structural Steel Seismic Requirements | There are no modifications to the standard adopted. | Since SBC does not have additional requirements for special concentrically braced frames, NEHRP is more stringent. Thus, the sections are equivalent except in the case of special concentrically braced frames. |
| 5.3 Cold-Formed Steel Seismic Requirements | This section references *Seismic Provisions for Structural Steel Buildings* (1992), *Specification for the Design of Cold-Formed Steel Structural Members* (1986), and *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* (1991). Modifications to the references are included. The most notable modification is the use of an earthquake load factor of 1.0 instead of 1.5. | 2204 Cold-Formed Steel Construction | No changes | SBC already has the changes NEHRP has made. Thus, the sections are judged equivalent. |
| 5.7 Light-Framed Walls | Specification for the Design of Cold-Formed Steel Structural Members, Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members and Specification for the Design of Cold-Formed Stainless Steel Structural Members are referenced. | 2213 Lateral Resistance For Steel Stud Wall Systems | This section adds requirements for Cold-Formed Steel Stud-Wall Systems. | Since SBC has additional requirements than the two references, it is more stringent than NEHRP. Thus, the sections are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 6.1 Reference Documents | The revised version of ACI 318-89 is used as a reference. The revised version includes Building Code Requirements for Structural Plain Concrete. | 3502 Referenced Standards | SBC adopted ACI 318-95 for reinforced and plain concrete. | Since SBC is using the later version of ACI 318, it is more up to date than NEHRP. Thus, the sections are equivalent. |
| 6.1.1.4 | Requirements for precast elements that are part of the lateral-force-resisting system were added. | 1912.1.1 Modifications to ACI 318-95 | No changes | SBC already has this modification, but expands it to systems not satisfying the requirements of the chapter, making it more stringent. Thus, the sections are equivalent. |
| 6.1.1.13 | Provisions for coupling beams were added. | 1912.1.1 Modifications to ACI 318-95 | No changes | Since SBC already has this modification, the sections are equivalent. |
| 6.2.4 Strength Based on Calculations | The formula to calculate the tensile strength governed by concrete failure was revised. Two formulas which depend on the spacing of the anchors are given. | 1914.1.4 Strength in Tension | No changes | Since SBC already has this modification, the sections are equivalent. |
| 6.5.1 Ordinary Moment Frames | New requirements for ordinary moment frames with seismic performance category B were added. | 1912.1.3.1 Ordinary Moment Frames in Seismic Performance Category B | No changes | Since SBC already had this provision, the sections are equivalent. |
| 6.6.3 Plain Concrete | New requirements for plain concrete footings, walls in the basement, foundation, or other walls below the base with seismic performance category C were added. | 1912.2.3 Seismic Performance Category C | New requirements for plain concrete footings, walls in the basement, foundation, or other walls below the base with seismic performance category C were added. | Since both codes make the same changes, the two sections are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 6.7.4 Plain Concrete | A new provision states that structural members of plain concrete are not permitted in buildings assigned to category D or E (with some exceptions). | 1912.2.4 Seismic Performance Category D and E | No changes | Since SBC already had this provision, the sections are equivalent. |
| Appendix to Chp. 6 Reinforced Concrete Structural Systems Composed from Inter-connected Precast Elements | A new appendix was added to introduce provisions for structural systems composed of precast concrete elements interconnected with dry connections. | | No equivalent section | Although SBC does not have equivalent provisions, the appendix in NEHRP is just an introduction to the systems. Therefore, the sections may be considered equivalent. |
| | No equivalent section | 1903.2 Cements | This section adds ASTM C 595 and ASTM C 845 as cement standards. | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1903.5.2 Steel Reinforce-ment | This section now requires welding of reinforcing to conform to ANSI/AWS D1.4. | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1903.6 Admixtures | This section now requires admixtures to conform to ACI 318-95 | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | Table 1904F Requirements For Concrete Exposed To Deicing Chemicals | This table replaces sections for limitations on use of certain cementitious materials. The limits are the same as in the previous edition. | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| | No equivalent section | 1905.4 Proportioning Without Field Experience or Trial Mixtures | This section now allows concrete proportions to be based on other experience or information, rather than Table 1905.4 (deleted). | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1907.2 Removal of Forms, Shores, and Reshoring | This section was reordered. Schedules, submittals, and unshored construction were added to the section. | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 1915 Shotcrete | This section was added to provide requirements for shotcrete. | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |

### CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 7.5.1 Composite Slabs | The requirements for designing composite slabs are included in this section. | 2211 Composite Slabs | This section now references ASCE 3 for the design of composite slabs. | Since both codes use the same reference, these sections are judged equivalent. |

### CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 8.3.7 Seismic Performance Category C | The screen wall requirements were removed. Requirements for walls separated from the basic structural system were added. The restriction on use of structural clay nonload-bearing wall tile (ASTM C56) was removed. | 2115.6 Seismic Performance Category C | No changes | Since SBC did not remove the requirements that NEHRP did, it is more stringent. Thus, the sections are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 8.3.9 Seismic Perfomance Category E<br>8A.8.1 Construction Requirements | The requirement for solid grouting of structural masonry that is not part of the seismic resisting system was removed. | 2115.8 Seismic Perfomance Category E | No changes | Since SBC did not remove the requirements that NEHRP did, it is more stringent. Thus, the sections are judged equivalent. |
| 8.3.10 Properties of Materials | The table which contained values of the modulus of elasticity (8.3.10.2) was removed in lieu of calculating the modulus using Eq. 8.3.10.2. The values of modulus of rupture in Table 8.3.10.5.1 were revised. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses the table previously used in NEHRP. The table results in lower moduli in clay masonry and concrete masonry with a strength greater than 3000 psi. Since a lower modulus results in a lower stiffness, SBC is more stringent except for concrete masonry with low strengths. Thus, the sections are equivalent. |
| 8.3.12 Plate, Headed and Bent Bar Anchor Bolts | The calculations for the design axial and shear strengths were revised (Eq. 8.3.12.1-1, 8.3.12.1-2, 8.3.12.2-1, 8.3.12.2-2). | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | A comparison of the equations indicates that ACI 530/ASCE 5/TMS 402-95 is more stringent in two of the four equations. Thus, neither section is more stringent, the sections may be considered equivalent. |
| 8.6.3 Design of Plain Unreinforced Masonry Members | The allowable flexural compressive stress for unreinforced masonry in non-seismic applications is now proportional to the strain up to 0.85f'm. The previous version limited this condition to 0.33f'm. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses the previous limit of 0.33f'm. Thus, SBC is more restrictive and the sections are equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 8.7.2 Shear Strength | The 2/3 factor that was applied to shear strength when comparing it to the shear demand was removed. | 2115.2 General | SBC uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses working stress equations to determine shear and, thus, a direct comparison. However, since the intent of strength design is not to provide a more stringent method but to provide a more accurate method of design, the sections may be considered equivalent. |
| | No equivalent section | 2101.3.2 Support on Wood | This section added an exception to the restriction of masonry being supported by wood members. | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |
| | No equivalent section | 2103.1 Engineered Masonry Design | This section added exceptions to the use of ACI 530/ASCE 5/TME 402 for engineered masonry design. | Since NEHRP only has seismic provisions, which SBC also covers in 2115, SBC is more stringent with these extra provisions. Thus, the sections are judged equivalent. |
| | No equivalent sections | 2113 Masonry Chimneys<br>2114 Masonry Fireplaces and Barbecues | These sections added requirements for the construction of masonry chimneys, fireplaces, and barbecues. | Since the 1994 NEHRP has no provisions, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |

### CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 9.1 Reference Documents | Several reference documents have new editions and there are a few new references. | 3502 Referenced Standards | The referenced standards are more updated versions of the standards used by NEHRP. | Since SBC uses the more updated version of standards, it is just as or more stringent than NEHRP. Thus, the sections are equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 9.2 Strength of Members and Connections | The factor to multiply the allowable working stress has been increased from 2.0 to 2.16. The phi factors have been revised. The phi factor was reduced for members in flexure with compression. The categories of connectors have been revised. The phi factor was reduced for shear on diaphragms and shear walls. In general, with the increase in capacity and decrease in phi factor, the resulting nominal capacity is lower. | 2312.3 Strength of Members and Connections | No changes | SBC uses allowable stress design for wood. Using the strength increase and phi factors in NEHRP, the strength is increased more than the value of the load factors. Therefore, since NEHRP capacities are higher relative to the demand, the sections are judged equivalent. |
| 9.4.1 Construction Limitations, Conventional Construction | The limits for conventional construction for buildings have been revised. The height of the building is no longer a criteria. The required spacing between braced walls has been increased for seismic performance categories A and B. Previously all SPC A buildings could use conventional construction, now there are limitations. Previously the maximum number of stories permitted for conventional construction of SPC C building was 1 and now it is 2. Previously SPC D buildings could not utilize conventional construction in seismic hazard exposure groups II and III, and now conventional construction may be used for one story buildings with a maximum distance between braced walls of 25ft. | | No equivalent section | Since there are no conventional construction procedures in SBC, it is more stringent than NEHRP. Thus, the sections are judged equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| 9.8.1 Framing Requirements | No changes | 2309.1 Ceiling Joist and Rafter Framing | This section added the requirement that ceiling joists shall have a minimum bearing surface of 1.5 inches on the top plate at each end. Requirements were added for openings in ceiling framing. | Since NEHRP has no specific provisions for minimum bearing surface, SBC is more stringent. Thus, the sections are judged equivalent. |
| 9.9.1.1 Structural-Use Shear Panels | There are no restrictions for the use of particleboards. | 2307.6 Subfloors | This section removed the use of particleboard as subflooring (Table 2307.6C was deleted). | Since there are no restrictions in NEHRP on the use of particleboards, SBC is more stringent. Thus, the sections are equivalent. |
| 9.9.1.1 Structural-Use Shear Panels | There are no restrictions for the use of particleboards. | Table 2308.1C Allowable Spans for Particleboard Wall Sheathing | Parts of this table were deleted to reflect restricted use of particleboard. | Since there are no restrictions in NEHRP on the use of particleboards, SBC is more stringent. Thus, the sections are equivalent. |
| 9.9.1.1 Structural-Use Shear Panels | There are no restrictions for the use of particleboards. | 2309.3 Roof Sheathing | This section removed the use of particleboard as roof sheathing (Table 2309.3B was deleted). | Since there are no restrictions in NEHRP on the use of particleboards, SBC is more stringent. Thus, the sections are equivalent. |
| 9.9.1.1 Structural-Use Shear Panels | There are no restrictions for the use of particleboards. | 2311 Particleboard Shear Walls | This section has been modified such that particleboard is no longer allowed to be used as horizontal diaphragm elements, only shear walls and other vertical diaphragm elements. | Since there are no restrictions in NEHRP on the use of particleboards, SBC is more stringent. Thus, the sections are equivalent. |
| | No equivalent section | 2308.2.2 Wall Bracing | This section added requirements for wood board as use for wall bracing. | Since the 1994 NEHRP has no provisions for woodboard used as wall bracing, the 1997 SBC is more restrictive. Thus, the sections are equivalent. |

## Table 3B: Changed Provisions in SBC and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | 1997 SBC | Changes | Comments |
|---|---|---|---|---|
| | No equivalent section | 2308.3 Openings in Exterior Walls<br>Tables 2308.3A-C Header Spans | This section and tables have been reorganized since the previous version. The section now simply refers to the Tables and the Tables are organized to provide allowable header spans based on Ground Snow Load, Building Width, Support Conditions, and Support Members. | Since NEHRP has no specific provisions, SBC is more stringent. Thus, the sections are judged equivalent. |
| | No equivalent section | 2308.5, Table 2308.5 Interior Bearing Partitions | This section now allows interior bearing partitions in one and two family dwellings to use lower requirements in Table 2308.5 rather than the requirements for exterior bearing walls in 2308.3. | Since NEHRP has no specific provisions, SBC is more stringent. Thus, the sections are judged equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| CHAPTER 1: GENERAL PROVISIONS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **ASCE 7-95** | **Changes** | **Comments** |
| 1.6 Quality Assurance | Quality assurance provisions now apply to other designated seismic systems in seismic perfomance category D. | A.9.1.6 Quality Assurance | In addition to seismic perfomance category E, quality assurance provisions now apply to other designated seismic systems in SPC C and D buildings. The requirement for quality assurance for other designated seismic systems in buildings with SPC C, D, and E is now required only for components with an importance factor Ip of 1.5. | NEHRP requires quality assurance provisions for other designated seismic systems for SPC D and E buildings whereas ASCE 7 requires it for SPC C, D, and E buildings. In this respect, ASCE 7 is more stringent and the sections are equivalent. NEHRP requires quality assurance provisions for other designated seismic systems for components of any importance factor, however, ASCE 7 requires it for components with Ip=1.5. In this respect, NEHRP is more stringent and the sections are not equivalent. |
| 1.6.2.1 Foundation Special Inspection | The requirement for continuous special inspection for placement of concrete was added. The requirement for continuous special inspection for construction of drilled piles and caissons was changed to periodic inspection. The requirement for periodic inspection for placement of reinforcing steel was added. | A.9.1.6.2.1 Foundation Special Inspection | The requirement for continuous special inspection for placement of concrete in deep foundations was added. The requirement for continuous special inspection for construction of drilled piles and caissons was changed to periodic inspection. The requirement for periodic inspection for placement of reinforcing steel was added. | The only difference in foundation special inspection relates to concrete placement. ASCE 7 requires special inspection for the placement of concrete in deep foundations whereas NEHRP requires it for all foundations. Therefore, NEHRP is more stringent and the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 2.2.2 Structural Framing Systems | New building frame systems, particularly relating to composite systems, were added. R and Cd values for ordinary moment frames of reinforced concrete and intermediate moment frames of reinforced concrete were increased. | 9.2.2.2 Structural Framing Systems | New buildings frame systems related to plain concrete shear walls and special concentrically-braced frames of steel were added. | Because of the new composite systems added in NEHRP, there are more structural system categories than ASCE 7. ASCE 7 does not provide a method or a rational basis for designing composite systems, however, it does not specifically prohibit it either. Since NEHRP addresses composite systems, the sections are not equivalent. With respect to R and Cd values, there are slight differences in the tables with neither table consistently providing more stringent values. Therefore, with respect to R and Cd values, the documents are essentially equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 2.2.6 Combination of Load Effects | Load combinations are referenced to ANSI/ASCE 7-93 which differ from the previously given combinations. In earthquake load combinations, the dead load factor is slightly higher but the live and snow load factors are typically lower. The vertical earthquake loads depend on Ca where they previously depended on Av. The new vertical loads will be less for soil profile A, equivalent for soil type B and in most cases they will be larger for soil types C, D and E. | 2 Combinations of Loads<br>9.2.2.6 Combination of Loads | In the new document, flood loads are a consideration and ponding is no longer included in the load combinations. Previously fluid, soil, and self straining forces were not included in the basic load combinations but were required to be considered. In the new document, the loads are included in the load combination that does not include wind or earthquake loads. Therefore, fluid, soil, and self-straining forces would previously be considered in combination with wind and/or earthquake loads and now they would not. A reduction in allowable stress design combinations is no longer allowed for combinations involving earthquake loads. The vertical earthquake loads depend on Ca where they previously depended on Av. The new vertical loads will be less for soil profile A, equivalent for soil type B and in most cases they will be larger for soil types C, D and E. | NEHRP references the previous version of ASCE 7 for load combinations. In ASCE 7-95, fluid, soil and self-straining forces are not considered in combination with earthquake and wind forces, where previously they were. In this case, the sections are not equivalent. When load reductions may be applied, NEHRP loads may be less than ASCE 7-95 since a reduction may be applied on earthquake load combinations in ASCE 7-93 whereas it is not allowed in ASCE 7-95. In this case, ASCE 7-95 is more stringent and the sections are equivalent. The changes to the vertical earthquake loads are equivalent in the documents. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 2.2.7 Deflection and Drift Limits | The category for single story buildings in the allowable drift limit table was deleted. Previously there was no limit on the allowable drift for single story buildings in seismic hazard exposure group I. New stringent allowable drift limits have been specified for masonry buildings. | 9.2.2.7 Deflection and Drift Limits | The category for single story buildings in the allowable drift limit table was deleted. Previously there was no limit on the allowable drift for single story buildings in seismic hazard exposure group I. | Besides masonry buildings, the allowable drift limits are equivalent. NEHRP has strict drift limits that apply to masonry building which ASCE 7 does not. Drift is usually only a concern for frame buildings, in which case the documents are not equivalent for masonry frame buildings. Drift is a measure of damage and not a life safety issue. In that respect, the documents are equivalent from a performance standpoint. |

### CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 3.2.2 Architectural Component Forces and Displace-ments | This section contains the new response coefficients to calculate the seismic loads on architectural components. | 9.3.2.2 Architectural Component Forces and Displace-ments | This section contains the new response coefficients to calculate the seismic loads on architectural components. | The only difference between the sections relates to powder-actuated fasteners. NEHRP states that they may not be used for anchorage in seismic performance categories D and E. ASCE 7 gives a Rp value that is half the value that is in NEHRP. Thus, NEHRP is more stringent when it prohibits the use of powder-actuated fasteners, however, ASCE 7 is more stringent in the design load when NEHRP allows it. Thus, the sections are not equivalent. |
| 3.2.4 Exterior Wall Panel Connections | This section contains force and displacement requirements for exterior wall panel connections. | 9.3.2.4 Exterior Wall Panel Connections | This section contains force and displacement requirements for exterior wall panel connections. | The force requirements are higher in NEHRP. Thus, NEHRP is more stringent and the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 3.3 Mechanical and Electrical Components | Extensive requirements for bracing various mechanical and electrical components such as piping, elevators, and storage tanks are provided. | 9.3.3 Mechanical and Electrical Components | Extensive requirements for bracing various mechanical and electrical components such as piping, elevators, and storage tanks are provided. | For certain HVAC system equipment and electrical communication equipment, ASCE 7 has higher response factors which will result in lower loads. Thus, NEHRP is more stringent in the previously stated cases, and the sections are not equivalent. |

### CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 4.4.3 Foundation Ties | The design loads for foundation ties are revised because of the change in seismic coefficients. | 9.4.4.3 Foundation Ties | No changes | The foundation tie design load is dependent on Av in ASCE 7 and on Ca in NEHRP. The load will be larger in NEHRP with soft soil conditions and will be less with hard rock. Thus, with soft soil conditions, the foundation tie requirements are not equivalent. |

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 6.1.1.4 | Requirements for precast elements that are part of the lateral-force-resisting system were added. | | No equivalent provision | Since no equivalent provision exists in ASCE 7, the sections are not equivalent. |
| 6.1.1.5 | Requirements for connections of precast concrete elements that emulate the behavior of monolithic reinforced concrete construction were added. | | No equivalent provision | Since no equivalent provision exists in ASCE 7, the sections are not equivalent. |
| 6.1.1.7 | Requirements for strong connections of precast concrete frames were added. | | No equivalent provision | Since no equivalent provision exists in ASCE 7, the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 6.1.1.8 | This section includes provisions for calculating the probable capacities of structural elements in precast concrete frames. | | No equivalent provision | Since no equivalent provision exists in ASCE 7, the sections are not equivalent. |
| 6.1.1.12 | This section contains additional requirements for concrete diaphragms. | | No equivalent provision | Since no equivalent provision exists in ASCE 7, the sections are not equivalent. |
| 6.1.1.13 | Provisions for coupling beams were added. | | No equivalent provision | Since no equivalent provision exists in ASCE 7, the sections are not equivalent. |
| 6.2.2 Strength of Anchors | A provision was added that states that anchors shall be detailed so that the connection failure is initiated by the failure of the anchor steel rather than by the failure of the surrounding concrete. | A.9.6.2.2 Strength of Anchors | No changes | Since ASCE 7 does not require a particular failure sequence, the sections are not equivalent. |
| 6.2.3 Strength Based on Tests | The strength reduction factor for anchors shall be 0.8 when the anchor failure governs in the majority of tests and 0.65 when the concrete failure controls. | A.9.6.2.2 Strength of Anchors | No changes | ASCE 7 does not specify a strength reduction factor for the strength of anchors in tests. Therefore, NEHRP is more stringent and the sections are not equivalent. |

### CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| Chapter 7 Composite Steel and Concrete Structure Design Requirements | This new chapter presents design and detailing requirements for composite structures that are expected to provide structural toughness, ductility, strength, and stiffness equivalent to comparable concrete and steel structures. | 9.7 Composite Structures | A section is reserved for composite structures, though no provisions have been added thus far. | Although ASCE 7 does not have any provisions relating to composite structures, it does not disallow it. The design of a composite structure would be up to the discretion of the designer. However, since ASCE 7 does not address composite system, the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 7.4 Composite Systems | Requirements to design composite systems (partially restrained frames, ordinary moment frames, special moment frames, concentrically braced frames, eccentrically braced frames, reinforced concrete walls composite with steel elements and composite shear walls) are in this section. The section outlines the design requirements for individual elements of the system. | | No equivalent provision | See above for discussion on composite systems. |
| 7.5.1 Composite Slabs | The requirements for designing composite slabs are included in this section. | 9.5 Steel<br>9.6 Structural Concrete | See specific material sections for any changes | Although NEHRP references documents common to ASCE 7, it provides additional requirements. Thus, the sections are not equivalent. |
| 7.5.2 Composite Beams | Additional requirements for special moment frames are given as follows. A maximum distance from the maximum concrete compression fiber to the plastic neutral axis is given. Compression elements that are fully encased by a reinforced concrete cover (min 2") do not need to meet the width-thickness ratio provided that concrete is confined by hoop reinforcement in regions where plastic hinges are expected to occur. | 9.5 Steel | See steel section for any changes | The documents are equivalent in composite beam design requirements since they both reference LRFD. Since NEHRP is less stringent in the width-thickness requirement, the documents are equivalent in this respect. Since NEHRP has an extra requirement for the maximum distance to the plastic neutral axis, the documents are not equivalent in this respect. |
| 7.5.3 Encased Composite Columns | This section references LRFD for the design of encased composite columns. Additional requirements for seismic performance category C, D and E are given. Most of the additional requirements are related to concrete reinforcing. | 9.5 Steel<br>9.6 Structural Concrete | See specific material sections for any changes. | NEHRP requires additional concrete detailing that is similar to requirements in the ACI. Since ASCE 7 references LRFD and ACI the referenced provisions are the same but the concrete detailing would not be used in conjunction with steel as NEHRP requires it. Thus, the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 7.5.4 Filled Composite Columns | This section outlines the requirements for filled composite columns. LRFD is referenced and additional requirements are given for seismic performance categories D and E. | 9.5 Steel<br>9.6 Structural Concrete | See specific material sections for any changes. | NEHRP has additional requirements for composite columns that uses sections from various references. Although ASCE 7 references the same documents, the provisions are not required in conjunction with each other. Thus, the sections are not equivalent. |
| 7.6 Composite Connections | This section includes requirements for connections in structures with composite or dual steel-concrete systems where seismic loads are transferred. | 9.5 Steel<br>9.6 Structural Concrete | See specific material sections for any changes. | ASCE 7 does not have a section dedicated to composite connections. Much of the requirements in NEHRP reference documents that ASCE 7 references. Since there are additional requirements, the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

### CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 8.1 General | The masonry structure design approach was changed from working stress design to limit states design. | 9.8 Masonry | This section incorporates ACI 530/ASCE 5/TMS 402-95 in its entirety. Modifications to this reference were removed. | ACI 530/ASCE 5/TMS 402-95 did incorporate strength design for the seismic provisions. Therefore, the methodology approach is the same. However, rather than develop a separate set of strength design provisions, the standard takes the existing working stress design methodology and uses load factors, phi factors, and a 3.325 increase of allowable working stress values. The detailing provisions in the standard essentially remain the same. In comparing ACI 530 and NEHRP, the formulas to calculate strength capacities appear to be equivalent, although NEHRP tends to be a bit more restrictive. In the detailing provisions, similar checks are required in both documents. However, NEHRP is more restrictive with the parameters it sets, such as maximum size of reinforcement, bundling of reinforcing bars, and hook development lengths in tension. Based on the comparison of ACI 530 and NEHRP, NEHRP appears to be more stringent. Thus, the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 8.3.7 Seismic Perfomance Category C | The screen wall requirements were removed. Requirements for walls separated from the basic structural system were added. The restriction on use of structural clay nonload-bearing wall tile (ASTM C56) was removed. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not have provisions for walls separated from the basic structural system. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.3.8 Seismic Perfomance Category D | The required roughened surface exposure for concrete placement next to masonry that is not designed with a separation joint was increased from 1/16" to 1/8". | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not have provisions for roughened surface exposure for concrete placement next to masonry. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.4.3 Placement Limits for Reinforce-ment | Bundling of bars is no longer allowed. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 allows the use of bundled bars. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.4.5 Development of Reinforce-ment | The calculation of embedment length (Eq. 8.4.5.2) was modified. A requirement for 6 inches of minimum embedment length for wire was added. The calculation of embedment length for hooks (Eq. 8.4.5.4.2) was modified. Lap splices are no longer allowed in plastic hinge zones. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | Due to the equation parameters, a direct comparison was not possible. However, the equation in ACI 530/ASCE 5/TMS 402-95 only considers the diameter of the bar and the strength of steel. The equations in NEHRP also take into account clear cover and strength of masonry. Based on this, NEHRP may be considered more stringent and the sections are not equivalent. |
| 8.5.4 Deformation Requirements | This section was rewritten to be consistent with the deformation criteria set forth in Chapter 2. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain deformation provisions, only strength provisions. Thus, NEHRP is more restrictive and the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 8.6.2 Design Requirements of Reinforced Masonry Members | The critical strain ratio was reduced from 0.003 to 0.002. The critical strain ratio is used to calculate the maximum reinforcement ratio. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not define a critical strain ratio. Thus, NEHRP is more stringent and the sections are not equivalent. |
| 8.7.3 Design of Reinforced Masonry Members | The equations to calculate shear strength in both the masonry and reinforcing steel were modified (Eq. 8.7.3.2-1, 8.7.3.3). | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses one equation for calculating the shear capacity, independent of the steel reinforcement provided. NEHRP uses separate equations for calculating shear capacities of masonry and steel. Since NEHRP is the more accurate of the two methods, is may be considered more stringent. Thus, the sections are not equivalent. |
| 8.11.2 Confinement of Compressive Stress Zone | The requirement for confinement was changed from a strain limit to the plastic hinge zone regions. The definition of a confined compressive zone was added. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for confinement of the compressive stress zone. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.11.3 Flanged Shear Walls | A requirement was added that states that solid units shall be laid in running bond and 50% of the masonry units at wall intersections shall be interlocked. The effective width of flange in compression was changed from 1/6 of the wall height to 9 times the thickness of the web. The effective width of flange in tension was changed from 1/3 of the wall height to 3/4 of the wall height. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for flanged shear walls. Thus, NEHRP is more restrictive and the sections are not equivalent. |

## Table 4A: Changed Provisions in ASCE 7 and NEHRP Judged Not Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 8.12 Wall Frames | The requirement of where plastic hinges shall be formed was removed. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frames. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.4 Reinforce-ment | A new restriction requires that actual yield strength shall not exceed 1.5 times the nominal yield strength. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame reinforcement. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.5 Wall Frame Beams | An additional restriction that the reinforcement ratio shall be less than 0.15f'm/fy was added. The maximum spacing of transverse reinforcement was increased from 1/4 of the beam depth to 1/2 of the beam depth. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame beams. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.6 Wall Frame Columns | The limit of factored axial compression force was changed from 0.30Anf'm to 0.15Anf'm. The limit of minimum column dimension was decreased from 32 inches to 24 inches. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame columns. Thus, NEHRP is more restrictive and the sections are not equivalent. |
| 8.12.7 Wall Frame Beam-Column Intersection | The definition of the dimension of the beam-column intersection was changed from a multiple of the bar diameters to Eq. 8.12.7.1-1 and Eq. 8.12.7.1-2. A restriction that the shear stress shall not exceed 7 roots f'm was added. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does not contain provisions for wall frame beam-column intersections. Thus, NEHRP is more restrictive and the sections are not equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| CHAPTER 1: GENERAL PROVISIONS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **ASCE 7-95** | **Changes** | **Comments** |
| 1.2 Scope | This section lists structures that are exceptions to seismic design provisions. Exceptions for one and two family dwellings that were previously dependent on Av, were revised to depend on a new coefficient Ca. | 1.1 Scope<br>9.1.2 Scope | No major changes to section 1.1.<br>In section 9.1.2, the exceptions to seismic design provisions were revised. The exception for one and two family dwellings in areas where the effective peak velocity related acceleration Av is less than 0.15 was revised to areas where Av is less than 0.10. One and two family dwellings where the seismic coefficient Ca is less than 0.15 is a new exception. One and two family wood frame dwellings not included in the above stated exceptions with not more than two stories that are constructed in accordance with the conventional construction requirements are a new exception. | ASCE 7 has the additional exception for one and two family dwellings in areas where the effective peak velocity related acceleration Av is less than 0.10. Dwellings with this criteria is most likely encompassed by the exception when the seismic coefficient Ca is less than 0.15. Thus, this extra exception does not have a significant implication. All other exceptions are equivalent. Thus, the sections are equivalent. |
| 1.4.2 Seismic Coefficients | Six new soil profile types are defined in this section where previously there were 4. Seismic coefficients Ca and Cv, which depend on soil profile and seismic zone, are introduced in this section. Ca and Cv replace AaS and Av in the 1991 provisions. All provisions that were previously related to Av and Aa were revised to reflect the new coefficients. | 9.1.4.2 Seismic Coefficients | Six new soil profile types are defined in this section where previously there were 4. Seismic coefficients Ca and Cv, which depend on soil profile and seismic zone, are introduced in this section. Ca and Cv replace AaS and Av in 93 standards. All provisions that were previously related to Av and Aa were revised to reflect the new coefficients. | The seismic coefficients are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 1.4.3 Seismic Hazard Exposure Group | No changes | 1.5 Classification of Buildings and Other Structures | The category numbering has been revised. In the new document, category I represents structures with a low hazard to human life in the event of failure, and category IV represents essential facilities. Category III was expanded to include various types of occupancies such as schools, health care facilities, and jails. | NEHRP contains three seismic hazard exposure groups, whereas ASCE 7 contains four classifications. The two highest classifications are essentially equivalent. The only difference is that NEHRP puts buildings containing sufficient quantities of toxic or explosive substances in a higher category than ASCE 7. The lowest category in ASCE 7 includes structures that represent a low hazard to human life in the event of failure, however the lowest category in NEHRP is all buildings not classified in the other two groups. Category II in ASCE 7 is all buildings not classified in the other three groups. Since ASCE 7 has a most stringent system of classification, the sections are equivalent. |
| 1.4.4 Seismic Performance Category | The seismic performance category for seismic hazard exposure group III buildings with values of Av ranging from 0.10 to 0.15g was increased from C to D to reduce the risk of collapse in essential service buildings in regions of moderate seismicity. | 9.1.4.4 Seismic Performance Category | The seismic performance category for seismic hazard exposure group III buildings with values of Av ranging from 0.10 to 0.15g was increased from C to D to reduce the risk of collapse in essential service buildings in regions of moderate seismicity. | The seismic performance categories are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.2.1 Special Inspection for Reinforcing Steel | The requirement for periodic special inspection during and upon completion of reinforcing steel placement in intermediate concrete moment frames and concrete shear walls was added. The requirement for periodic special inspection of the placement of steel in reinforced masonry shear walls and ordinary moment frames was deleted. | A.9.1.6.2.2.1 Special Inspection for Reinforcing Steel | The requirement for periodic special inspection during and upon completion of reinforcing steel placement in intermediate concrete moment frames and concrete shear walls was added. The requirement for periodic special inspection of the placement of steel in reinforced masonry shear walls was deleted. | The special inspection requirements for reinforcing steel are equivalent. |
| 1.6.2.2.2 Special Inspection for Reinforcing Steel | The requirement for continuous special inspection during the welding of reinforcing steel was defined to pertain to steel resisting flexural and axial forces in intermediate and special moment frames of concrete, and in boundary members of concrete shear walls. | A.9.1.6.2.2.2 Special Inspection for Reinforcing Steel | The requirement for continuous special inspection during the welding of reinforcing steel was defined to pertain to steel resisting flexural and axial forces in intermediate and special moment frames of concrete, and in boundary members of concrete shear walls. | The special inspection requirements for reinforcing steel welding are equivalent. |
| 1.6.2.3 Special Inspection of Concrete | The requirement for special inspection during and on completion of the placement of concrete for intermediate and special moment frames and boundary members of concrete shear walls was added. The requirement for periodic special inspection during placement of concrete in reinforced concrete frames and shear walls was deleted. | A.9.1.6.2.3 Special Inspection of Concrete | The requirement for special inspection during and on completion of the placement of concrete for intermediate and special moment frames and boundary members of concrete shear walls was added. The requirement for periodic special inspection during placement of concrete in reinforced concrete frames and shear walls was deleted. | The special inspection requirements for concrete are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.4 Special Inspection of Prestressed Concrete | The requirement for special inspection after the completion of placement of prestressing steel was added. | A.9.1.6.2.4 Special Inspection of Prestressed Concrete | The requirement for special inspection after the completion of placement of prestressing steel was added. | The special inspection requirements for prestressed concrete are equivalent. |
| 1.6.2.6.1 Special Inspection of Structural Steel Welding | An exception to continuous special inspection in lieu of periodic inspection for welds loaded to less than 50 percent of their design strength was added. | A.9.1.6.2.6.1 Special Inspection of Structural Steel Welding | An exception to continuous special inspection in lieu of periodic inspection for welds loaded to less than 50 percent of their design strength was added. | The special inspection requirements for structural welding are equivalent. |
| 1.6.2.6.2 Special Inspection of Structural Steel Bolts | Bolts in connections identified as not being slip-critical or subject to direct tension need not be inspected for bolt tension other than to ensure that the plies of the connected elements have been brought into snug contact. | A.9.1.6.2.6.2 Special Inspection of Structural Steel Bolts | Bolts in connections identified as not being slip-critical or subject to direct tension need not be inspected for bolt tension other than to ensure that the plies of the connected elements have been brought into snug contact. | The special inspection requirements for structural steel bolts are equivalent. |
| 1.6.2.7.1 Special Inspection of Structural Wood | The requirement for continuous special inspection during field gluing operations was defined to be for elements of the seismic force resisting system. | A.9.1.6.2.7.1 Special Inspection of Structural Wood | The requirement for continuous special inspection during field gluing operations was defined to be for elements of the seismic force resisting system. | The special inspection requirements for structural wood are equivalent. |
| 1.6.2.7.2 Special Inspection of Structural Wood | The requirement for periodic special inspection for nailing, bolting, anchoring, and other fastening was defined to pertain to all seismic components. | A.9.1.6.2.7.2 Special Inspection of Structural Wood | The requirement for periodic special inspection for nailing, bolting, anchoring, and other fastening was defined to pertain to all seismic components. | The special inspection requirements for structural wood are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 1.6.2.8 Special Inspection of Architectural Components | The criteria for requiring special inspection changed from the performance criteria factor P, which depends on seismic hazard exposure group and the item to be braced, to the seismic performance category, which depends on Av and seismic hazard exposure group. Exceptions to periodic special inspection were added and additional items requiring inspection was added. | A.9.1.6.2.8 Special Inspection of Architectural Components | The criteria for requiring special inspection changed from the performance criteria factor P, which depends on seismic hazard exposure group and the item to be braced, to the seismic performance category, which depends on Av and seismic hazard exposure group. Exceptions to periodic special inspection were added and additional items requiring inspection was added. | The special inspection requirements for architectural components are equivalent. |
| 1.6.2.9 Special Inspection of Mechanical and Electrical Components | The criteria for requiring special inspection changed from performance criteria P to seismic performance category (see above). The items requiring special inspection were revised. | A.9.1.6.2.9 Special Inspection of Mechanical and Electrical Components | The criteria for requiring special inspection changed from performance criteria P to seismic performance category (see above). The items requiring special inspection were revised. | The special inspection requirements for mechanical and electrical components are equivalent. |
| 1.6.3.1 Testing of Reinforcing Steel | The requirement for a sample at fabricator's plant and the testing of reinforcing steel used in certain applications was deleted. | A.9.1.6.1.1 Testing of Reinforcing Steel | The requirement for a sample at fabricator's plant and the testing of reinforcing steel used in certain applications was deleted. | The testing requirements for reinforcing steel are equivalent. |
| 1.6.3.1.1 Testing of Reinforcing Steel | The requirement to examine the certified mill test reports for each shipment of reinforcing steel was defined to pertain to steel used to resist flexural and axial forces in reinforced concrete intermediate and special moment frames and boundary members of reinforced concrete or reinforced masonry shear walls. | A.9.1.6.3.1.1 Testing of Reinforcing Steel | The requirement to examine the certified mill test reports for each shipment of reinforcing steel was defined to pertain to steel used to resist flexural and axial forces in reinforced concrete intermediate and special moment frames and boundary members of reinforced concrete or reinforced masonry shear walls. | The testing requirements for reinforcing steel are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 1.6.3.1.2 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is used to resist earthquake-induced flexural and axial forces in special moment frames and in wall boundary elements of shear walls in buildings of seismic performance category D and E, verify that the requirements of Sec. 21.2.5.1 of Ref. 6-1 have been satisfied. | A.9.1.6.3.1.2 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is used to resist earthquake-induced flexural and axial forces in special moment frames and in wall boundary elements of shear walls in buildings of seismic performance category D and E, verify that the requirements of Sec. 22.2.5.1 of Ref. 9.6-1 have been satisfied. | The testing requirements for reinforcing steel are equivalent. |
| 1.6.3.1.3 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is to be welded, verify that chemical tests have been performed to determine weldability in accordance with Sec. 3.5.2 of Ref. 6-1. | A.9.1.6.3.1.3 Testing of Reinforcing Steel | Where ASTM A615 reinforcing steel is to be welded, verify that chemical tests have been performed to determine weldability in accordance with Sec. 3.5.2 of Ref. 9.6-1. | The testing requirements for reinforcing steel are equivalent. |
| 1.6.3.4.3 Testing of Structural Steel | ASTM A435 and ASTM A898 are added criteria on which to judge the acceptability of base metal thicker than 1.5 in. that is subject to through-thickness weld shrinkage strains. | A.9.1.6.3.4.3 Testing of Structural Steel | ASTM A435 and ASTM A898 are added criteria on which to judge the acceptability of base metal thicker than 1.5 in. that is subject to through-thickness weld shrinkage strains. | The testing requirements for structural steel are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 2.3.2 Seismic Base Shear | The statement regarding the amount of snow load to include in the dead load weight was deleted. | 9.2.3.2 Seismic Base Shear | No changes | ASCE 7 states that where the flat roof snow load exceeds 30 psf, the design snow load shall be included in the seismic weight. With approval, the amount of snow load may be reduced to no less than 20% of the design snow load. NEHRP does not require snow load to be included in the seismic weight. Therefore, ASCE 7 is more stringent and the sections are equivalent. |
| 2.3.2.1 Calculation of Seismic Response Coefficient | In calculating Cs, the seismic response coefficient, Cv replaces AvS and Ca replaces Aa in the equations. Using these new coefficients, the base shear is lowered for structures on rock but is increased for structures on soft soils. The base shear of a structure is V=CsW. | 9.2.3.2.1 Calculation of Seismic Response Coefficient | In calculating Cs, the seismic response coefficient, Cv replaces AvS and Ca replaces Aa in the equations. Using these new coefficients, the base shear is lowered for structures on rock but is increased for structures on soft soils. The base shear of a structure is V=CsW. | The provisions for calculating the seismic response coefficient are equivalent. |
| 2.5 Soil-Structure Interaction Effects | No changes to the provisions, however, the provisions were moved from an appendix to the main body of the document. | 9.2.5 Soil-Structure Interaction Effects | Previously, ASCE 7 stated that soil-structure interaction effects may be incorporated by using a generally accepted procedure approved by the authority having jurisdiction. In the current document, provisions are included to incorporate soil-structure interactions. | The provisions for soil-structure interaction effects are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 2.6 Provisions for Seismically Isolated Structures | This is a new section based on the 1994 UBC Appendix Chapter 16, division III. The provisions have been modified to conform to the strength based design approach and nomenclature of the document. | 9.2.6 Provisions for Seismically Isolated Structures | This is a new section that includes various provisions relating to seismically isolated structures. | The provisions for seismically isolated structures are equivalent. |
| 2.7 Provisions for Nonbuilding Structures | This new section includes requirements to design all self-supporting structures, other than buildings, bridges and dams, that are supported by the earth, that carry gravity loads, and that may be required to resist the effects of an earthquake. | 9.2.7 Nonbuilding Structures | This new section includes requirements to design all self-supporting structures, other than buildings, vehicular bridges and dams, that are supported by the earth, that carry gravity loads, and that may be required to resist the effects of an earthquake. | ASCE 7 specifically excludes vehicular bridges from nonbuilding structures, whereas NEHRP excludes all bridges. Thus, ASCE 7 is more stringent and the sections are equivalent. All other provisions in this section are equivalent except as noted. |
| 2.7.1.2 | This section contains the requirements for strength acceptance criteria. | 9.2.7.1.2 | This section contains the requirements for strength acceptance criteria. | When an approved national standard defines acceptance criteria in terms of allowable stresses, ASCE 7 requires a direct comparison to be made. NEHRP allows for a comparison to be made with the loads reduced by 1.5. Thus, ASCE 7 is more stringent and the sections are equivalent. |
| Appendix to Chapter 2 Passive Energy Dissipation Systems | This section introduces new techniques for incorporating energy dissipation devices into earthquake resistant buildings. This section is included as an appendix because it is intended to be introduction. | | No equivalent section | Although ASCE 7 does not have an equivalent section, the appendix in NEHRP is just an introduction to the systems. Therefore, the sections may be considered equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| | No equivalent provision | 5.3 Flood Loads | This new section includes data and requirements to design for flood loads. | NEHRP references the previous version of ASCE 7, where flood loads are not a consideration. Although this is the case, floor loads are not related to the seismic safety of a building. Therefore, the sections may be judged equivalent. |

### CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 3.1 General | The requirements for architectural, mechanical, and electrical components have been revised. The exceptions to following the provisions are included. | 9.3.1 General | The requirements for architectural, mechanical, and electrical components have been revised. The exceptions to following the provisions are included. | Breakaway walls are an additional exception in ASCE 7. Therefore, breakaway walls would not need to follow the provisions in this section according to ASCE 7. Although this is the case, this is not a significant seismic life safety concern. Therefore, the sections may be considered equivalent. |
| 3.1.3 Seismic Forces | Previously, lateral force calculations for architectural and mechanical/electrical equipment were separated. In the new provisions, general formulas for all equipment are provided. The formulas depend on Ca, importance factor of the equipment, component amplification, response factors, and vertical location of the equipment in the building. | 9.3.1.3 Seismic Forces | Previously, lateral force calculations for architectural and mechanical/electrical equipment were separated. In the new provisions, general formulas for all equipment are provided. The formulas depend on Ca, importance factor of the equipment, component amplification, response factors, and vertical location of the equipment in the building. | The seismic force provisions are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 3.1.4 Seismic Relative Displacement | This new section introduces formulas to calculate the relative displacement that may occur between components. | 9.3.1.4 Seismic Relative Displace-ments | This new section introduces formulas to calculate the relative displacement that may occur between components. | The provisions for seismic relative displacement are equivalent. |
| 3.1.5 Component Importance Factor | New importance factors are introduced which depend on the severity of failure of the component. | 9.3.1.5 Component Importance Factor | New importance factors are introduced which depend on the severity of failure of the component. | The provisions for the component importance factors are equivalent. |
| 3.2.6 Suspended Ceilings | This new section outlines additional requirements for bracing suspended ceilings.<br>Design and construction references and minimum clearances are among the additional requirements. | 9.3.2.6 Suspended Ceilings | This new section outlines additional requirements for bracing suspended ceilings.<br>Design and construction references and minimum clearances are among the additional requirements. | The requirements for suspended ceilings are equivalent. |
| 3.2.7 Access Floors | This new section outlines additional requirements for bracing access floors. The weight used to calculate loads and the requirements for special access floors are included. | 9.3.2.7 Access Floors | This new section outlines additional requirements for bracing access floors. The weight used to calculate loads and the requirements for special access floors are included. | The requirements for access floors are equivalent. |
| 3.2.9 Steel Storage Racks | This new section outlines additional requirements for bracing steel storage racks. The weight used to calculate loads and the response factor to design storage racks is included. | 9.3.2.9 Steel Storage Racks | This new section outlines additional requirements for bracing steel storage racks. The weight used to calculate loads and the response factor to design storage racks is included. | The requirements for steel storage racks are equivalent. |

# Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

## CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1996 BOCA | Changes | Comments |
|---|---|---|---|---|
| 4.5.2 Foundation Ties | Individual spread footings are required to have ties only for soft soil, whereas previously ties were required for conditions when the soil is anything other than rock. | 9.4.5.2 Foundation Ties | This new section requires individual spread footings in seismic perfomance categories D and E with soil profile type E or F to be tied. | The requirements for foundation ties are equivalent. |

## CHAPTER 5: STEEL STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 5.1 Reference Documents | *Seismic Provisions for Structural Steel Buildings* by AISC was added as a reference, and as a result, the length of this chapter was reduced. Part I is based on AISC *LRFD* and Part II is based on AISC *ASD*. Updated versions of *LRFD* by AISC and *Standard Specification, Load Tables and weight Tables for Steel Joists and Joist Girders* are referenced. Another new reference is *Load and Resistance Factor Design Specification for Cold-formed Stainless Steel Structural Members.* | 9.5.1 Reference Documents | Updated versions of the reference documents are incorporated. | The reference documents are equivalent. |
| 5.2 Structural Steel Seismic Requirements | The design of structural steel members and connections to resist seismic forces shall be in accordance with ASD and LRFD. | A.9.5.2 Structural Steel Seismic Require-ments | The design of structural steel members and connections to resist seismic forces shall be in accordance with ASD and LRFD. | The requirements are equivalent. |
| 5.2.1 Require-ments for Special Concentrically Braced Frames | This section includes the modifications to the requirements of *Seismic Provisions for Structural Steel Buildings.* | A.9.5.2.1 Requirements for Special Concentri-cally Braced Frames | This section includes the modifications to the requirements of *Seismic Provisions for Structural Steel Buildings.* | The requirements for special concentrically braced frames are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 5.3 Cold-Formed Steel Seismic Requirements | This section references *Seismic Provisions for Structural Steel Buildings* (1992), *Specification for the Design of Cold-Formed Steel Structural Members* (1986), and *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* (1991). Modifications to the references are included. The most notable modification is the use of an earthquake load factor of 1.0 instead of 1.5. | A.9.5.3 Cold-Formed Steel Seismic Requirements | This section references *Seismic Provisions for Structural Steel Buildings* (1992), *Specification for the Design of Cold-Formed Steel Structural Members* (1986), and *Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* (1991). Modifications to the references are included. The most notable modification is the use of an earthquake load factor of 1.0 instead of 1.5. | The cold-formed steel seismic requirements are equivalent. |
| 5.7 Light-Framed Walls | *Specification for the Design of Cold-Formed Steel Structural Members, Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* and *Specification for the Design of Cold-Formed Stainless Steel Structural Members* are referenced. | A.9.5.7 Light-Framed Walls | *Specification for the Design of Cold-Formed Steel Structural Members, Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members* and *Specification for the Design of Cold-Formed Stainless Steel Structural Members* are referenced. | The requirements for light-framed walls are equivalent. |

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 6.1 Reference Documents | The revised version of ACI 318-89 is used as a reference. The revised version includes Building Code Requirements for Structural Plain Concrete. | 9.6.1 Reference Documents | The revised version of ACI 318-89 is used as a reference. The revised version includes Building Code Requirements for Structural Plain Concrete. | The reference documents are equivalent. |
| 6.2.4 Strength Based on Calculations | The formula to calculate the tensile strength governed by concrete failure was revised. Two formulas which depend on the spacing of the anchors are given. | A.9.6.2.2 Strength of Anchors | No changes | The provisions are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 6.2.4.3 Combined Tension and Shear | The interaction equations to check the capacity for a combination of tension and shear were revised. The result of the change is less stringent interaction equations. | A.9.6.2.2 Strength of Anchors | No changes | The interaction equations are equivalent. |
| 6.5.1 Ordinary Moment Frames | New requirements for ordinary moment frames with seismic performance category B were added. | A.9.6.5.1 Ordinary Moment Frames | This new section includes requirements for ordinary moment frames with seismic performance category B. | The ordinary moment frame requirements are equivalent. |
| 6.5.2 Moment Frames | A new provision was added that states that moment frames on soil profile type E or F with seismic performance category B shall be an intermediate moment frame. | A.9.6.5.2 Moment Frames | A new provision was added that states that moment frames on soil profile type E or F with seismic performance category B shall be an intermediate moment frame. | The requirements are equivalent. |
| 6.6.3 Plain Concrete | New requirements for plain concrete footings, walls in the basement, foundation, or other walls below the base with seismic performance category C were added. | A.9.6.6.3 Plain Concrete | New requirements for plain concrete footings, walls in the basement, foundation, or other walls below the base with seismic performance category C were added. | The requirements for plain concrete are equivalent. |
| 6.7.4 Plain Concrete | A new provision states that structural members of plain concrete are not permitted in buildings assigned to category D or E (with some exceptions). | A.9.6.7.4 Plain Concrete | A new provision states that structural members of plain concrete are not permitted in buildings assigned to category D or E (with some exceptions). | The requirements for plain concrete are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| Appendix to Chp. 6 Reinforced Concrete Structural Systems Composed from Inter-connected Precast Elements | A new appendix was added to introduce provisions for structural systems composed of precast concrete elements interconnected with dry connections. | | No equivalent provision | Although ASCE 7 does not have an equivalent section, the appendix in NEHRP is just an introduction to the systems. Therefore, the sections may be considered equivalent. |

### CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 7.2 Reference Documents | The reference documents are listed in this section. | 9.5 Steel<br>9.6 Structural Concrete | See specific material sections for any changes | The documents that NEHRP and ASCE 7 reference are equivalent. |
| 7.5 Composite Members | This section lays out the requirements for structural steel, reinforcing steel and concrete. The requirements refer to the steel and concrete codes. | 9.5 Steel<br>9.6 Structural Concrete | See specific material sections for any changes | Since NEHRP and ASCE 7 have the same references, the sections are equivalent. |

### CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 8.1.2 Reference Documents | Thirty-five material standard references were added. | 9.8.1 Reference Documents | ASCE 7 references ACI 530/ASCE 5/TME 402-95 for masonry design provisions. | The main design provisions are equivalent in the documents. Although there are no material standards references in ASCE 7, the sections are judged equivalent since material standards do not pose a life safety concern. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 8.3.9 Seismic Performance Category E<br>8A.8.1 Construction Requirements | The requirement for solid grouting of structural masonry that is not part of the seismic resisting system was removed. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 does have provisions for solid grouting of structural masonry that is not part of the seismic resisting system. Thus, ASCE 7 is more restrictive and the sections are equivalent. |
| 8.3.10 Properties of Materials | The table which contained values of the modulus of elasticity (8.3.10.2) was removed in lieu of calculating the modulus using Eq. 8.3.10.2. The values of modulus of rupture in Table 8.3.10.5.1 were revised. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses the table previously used in NEHRP. The table results in lower moduli in clay masonry and concrete masonry with a strength greater than 3000 psi. Since a lower modulus results in a lower stiffness, ASCE 7 is more stringent except for concrete masonry with low strengths. Thus, the sections are equivalent. |
| 8.3.12 Plate, Headed and Bent Bar Anchor Bolts | The calculations for the design axial and shear strengths were revised (Eq. 8.3.12.1-1, 8.3.12.1-2, 8.3.12.2-1, 8.3.12.2-2). | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | A comparison of the equations indicates that ACI 530/ASCE 5/TMS 402-95 uses the previous limit of 0.33f'm. Thus, ASCE 7 is more restrictive and the sections are equivalent. |
| 8.6.3 Design of Plain Unreinforced Masonry Members | The allowable flexural compressive stress for unreinforced masonry in non-seismic applications is now proportional to the strain up to 0.85f'm. The previous version limited this condition to 0.33f'm. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses the previous limit of 0.33f'm. Thus, ASCE 7 is more restrictive and the sections are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 8.7.2 Shear Strength | The 2/3 factor that was applied to shear strength when comparing it to the shear demand was removed. | | ASCE 7 uses ACI 530/ASCE 5/TMS 402-95 in its entirety. | ACI 530/ASCE 5/TMS 402-95 uses working stress equations to determine shear and, thus, a direct comparison is not possible. However, since the intent of strength design is not to provide a more stringent method but to provide a more accurate method of design, the sections may be considered equivalent. |

### CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 9.1 Reference Documents | Several reference documents have new editions and there are a few new references. | 9.9.1 Reference Documents | Several reference documents have new editions and there are a few changes in the references. | Since the reference to 1991 NDS is consistent in both documents, design specifications are essentially equivalent. Although there are a couple of differences in the reference documents, the sections are judged to be essentially equivalent. |
| 9.2 Strength of Members and Connections | The factor to multiply the allowable working stress has been increased from 2.0 to 2.16. The phi factors have been revised. The phi factor was reduced for members in flexure with compression. The categories of connectors have been revised. The phi factor was reduced for shear on diaphragms and shear walls. In general, with the increase in capacity and decrease in phi factor, the resulting nominal capacity is lower. | A.9.9.2.2 Strength Based Design | The phi factors have been revised. The phi factor was reduced for members in flexure with compression. Phi factors for connectors are given. The phi factor was reduced for shear on diaphragms and shear walls. | The provisions in the documents are equivalent. |

## Table 4B: Changed Provisions in ASCE 7 and NEHRP Judged Equivalent

| 1994 NEHRP | Changes | ASCE 7-95 | Changes | Comments |
|---|---|---|---|---|
| 9.4.1 Construction Limitations, Conventional Construction | The limits for conventional construction for buildings have been revised. The height of the building is no longer a criteria. The required spacing between braced walls has been increased for seismic performance categories A and B. Previously all SPC A buildings could use conventional construction, now there are limitations. Previously the maximum number of stories permitted for conventional construction of SPC C building was 1 and now it is 2. Previously SPC D buildings could not utilize conventional construction in seismic hazard exposure groups II and III, and now conventional construction may be used for one story buildings with a maximum distance between braced walls of 25ft. | A.9.9.4.1 Construction Limitations, Conventional Construction | The limits for conventional construction for buildings have been revised. The height of the building is no longer a criteria. The required spacing between braced walls has been increased for seismic performance categories A and B. Previously all SPC A buildings could use conventional construction, now there are limitations. Previously SPC D buildings could not utilize conventional construction in seismic hazard exposure groups II and III, and now conventional construction may be used for one story buildings with a maximum distance between braced walls of 25ft. | The limitations for conventional construction are equivalent. |
| 9.9.1.2 Shear Panels Sheathed with Other Sheet Materials | Previously, light framed walls sheathed with lath and plaster, gypsum sheathing boards, gypsum wallboard, or fiberboard sheets could be used to resist earthquake forces. Except in conventional construction, new provisions do not allow sheet materials other than structural-use materials to be part of the seismic force resisting system. | A.9.9.9.1.2 Shear Panels Sheathed with Other Sheet Materials | Previously, light framed walls sheathed with lath and plaster, gypsum sheathing boards, gypsum wallboard, or fiberboard sheets could be used to resist earthquake forces. Except in conventional construction, new provisions do not allow sheet materials other than structural-use materials to be part of the seismic force resisting system. | The provisions in the documents are equivalent. |

# Table 5A: Changed Provisions in OTFDC and NEHRP Judged Not Equivalent

## CHAPTER 1: GENERAL PROVISIONS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 1.3.2 Additions to Existing Buildings | No changes | 117.2 Additions, Alternations or Repairs | This new section states that any additions, alterations, or repairs to any structure shall conform to the present code, however, the existing structure is not required to conform to the requirements of the present code. | NEHRP states that an existing building addition shall be designed and constructed so that the entire building conforms to the seismic force resistance requirements for new buildings. Since NEHRP is more stringent than OTFDC, the sections are not equivalent. |
| | No equivalent provision | 109 Modifications | Modifications may be made to the provisions of the code if there are practical difficulties in conforming to the provisions. The modification must be approved by the building official and must not lessen the health, life safety and fire safety requirements. | Since NEHRP does not allow for modifications to be made, it is more stringent than OTFDC. Therefore, the sections are not equivalent. |

## CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 2.2.5.1.2 Anchorage of Concrete or Masonry Walls | Although there were no changes in this section, the formula to calculate the anchorage force in section 3.1.3 was revised. | 604.10 Anchorage | No changes | The typical anchorage that OTFDC requires appears sufficient for low seismic zones however, high seismic zone NEHRP loads will result in anchorage requirements that exceed OTFDC. Therefore, NEHRP is more stringent and the sections are not equivalent. |

## Table 5A: Changed Provisions in OTFDC and NEHRP Judged Not Equivalent

### CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 3.1 General | The requirements for architectural, mechanical, and electrical components have been revised. The exceptions to following the provisions are included. | 604.2.4 Parapet Walls | No changes | NEHRP has strict design load requirements for parapets. With some limitations, OTFDC allows unreinforced masonry parapets and there are no provisions for bracing. Therefore, NEHRP is more stringent and the sections are not equivalent with respect to parapets. In all other aspect of bracing, such as chimneys, veneers, and wall panels, NEHRP requires bracing whereas OTFDC does not. Therefore, with respect to bracing, the sections are not equivalent. |

### CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 4.4.3 Foundation Ties | The design loads for foundation ties are revised because of the change in seismic coefficients. | | No equivalent provision | Since OTFDC does not require foundation ties, NEHRP is more stringent and the sections are not equivalent. |
| 4.5.2 Foundation Ties | Individual spread footings are required to have ties only for soft soil, whereas previously ties were required for conditions when the soil is anything other than rock. | | No equivalent provision | Since OTFDC does not require foundation ties, NEHRP is more stringent and the sections are not equivalent. |

## Table 5A: Changed Provisions in OTFDC and NEHRP Judged Not Equivalent

### CHAPTER 5: STEEL STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 5.7 Light-Framed Walls | Specification for the Design of Cold-Formed Steel Structural Members, Load and Resistance Factor Design Specification for Cold-Formed Steel Structural Members and Specification for the Design of Cold-Formed Stainless Steel Structural Members are referenced. | 603 Metal | The type of material that metal structural elements in walls and partitions should be made of was deleted. The design references were deleted. | The only requirement that is contained in OTFDC for metal walls is that the elements should be straight and free of any defects. Thus, NEHRP is more stringent in requirements and the sections are not equivalent. |

## Table 5A: Changed Provisions in OTFDC and NEHRP Judged Not Equivalent

CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 6.7.4 Plain Concrete | A new provision states that structural members of plain concrete are not permitted in buildings assigned to category D or E (with some exceptions). | 404.1 Concrete and Masonry Foundation Walls | ACI 318.1 is referenced for the concrete and masonry foundation walls provisions. | The minimum thickness and maximum height of unbalanced fill are among the requirements given for masonry and concrete walls in seismic zones 3 and 4 in OTFDC. NEHRP exempts plain concrete footings and plain concrete foundation or basement walls provided the wall is not less than 7 1/2 inches thick and retains no more than 4 feet of unbalanced fill. in one and two family dwellings three stories or less in height. With a 4 foot maximum height of unbalanced fill OTFDC will allow plain concrete foundation walls. With more than 4 feet of unbalanced fill, reinforcement is required. Therefore, the sections are equivalent for seismic zones 3 and 4. One and two family dwellings in seismic zone 2 may be assigned to seismic performance category D. In this case, for plain concrete walls, more than 4 feet of unbalanced fill may be allowed in OTFDC whereas it is 4 foot maximum in NEHRP. Therefore, the sections are not equivalent for structures in seismic zone 2. |

# Table 5A: Changed Provisions in OTFDC and NEHRP Judged Not Equivalent

## CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 8.3.7 Seismic Performance Category C | The screen wall requirements were removed. Requirements for walls separated from the basic structural system were added. The restriction on use of structural clay nonload-bearing wall tile (ASTM C56) was removed. | | No equivalent provision | Since OTFDC does not have provisions for walls separated from the basic structural system, the sections are not equivalent. |
| 8.3.8 Seismic Performance Category D | The required roughened surface exposure for concrete placement next to masonry that is not designed with a separation joint was increased from 1/16" to 1/8". | | No equivalent provision | Since OTFDC does not have provisions for roughened surface exposure for concrete placement next to masonry, the sections are not equivalent. |
| 8.4.3 Placement Limits for Reinforce-ment | Bundling of bars is no longer allowed. | 604.11 Reinforce-ment | No changes | The reinforcement section in OTFDC does not address bundling of bars. Therefore, NEHRP is more restrictive and the sections are not equivalent. |
| 8.4.5 Development of Reinforce-ment | The calculation of embedment length (Eq. 8.4.5.2) was modified. A requirement for 6 inches of minimum embedment length for wire was added. The calculation of embedment length for hooks (Eq. 8.4.5.4.2) was modified. Lap splices are no longer allowed in plastic hinge zones. | | OTFDC references ACI 530/ASCE 5/TMS 402-91 | Due to the equation parameters, a direct comparison was not possible. However, the equation in ACI 530/ASCE 5/TMS 402-95 only considers the diameter of the bar and the strength of steel. The equations in NEHRP also take into account clear cover and strength of masonry. Based on this, NEHRP may be considered more stringent and the sections are not equivalent. |

# Table 5A: Changed Provisions in OTFDC and NEHRP Judged Not Equivalent

## CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 9.4.1 Construction Limitations, Conventional Construction | The limits for conventional construction for buildings have been revised. The height of the building is no longer a criteria. The required spacing between braced walls has been increased for seismic performance categories A and B. Previously all SPC A buildings could use conventional construction, now there are limitations. Previously the maximum number of stories permitted for conventional construction of SPC C building was 1 and now it is 2. Previously SPC D buildings could not utilize conventional construction in seismic hazard exposure groups II and III, and now conventional construction may be used for one story buildings with a maximum distance between braced walls of 25ft. | 602.9 Wall Bracing | An alternate to the minimum 48 inch panel width was added. | NEHRP requires the use of bracing walls at a specified spacing. OTFDC requires let in bracing at a specified spacing. Therefore, NEHRP is more stringent and the sections are not equivalent. The conventional construction limitations are more stringent in NEHRP. NEHRP prescribes a maximum number of stories according to seismic performance category in which a structure may use conventional construction. OTFDC allows all one and two family dwellings with no more than 3 stories to follow the code, which is similar to conventional construction. NEHRP references OTFDC for conventional construction provisions, therefore, when conventional construction is permitted in NEHRP, the sections are equivalent. In the cases where conventional construction is not allowed in NEHRP but is still within the realm of OTFDC limits, NEHRP would require a engineered structure and the sections are not equivalent. The structures in OTFDC for which conventional construction is not allowed in NEHRP are 3 story SPC C, 2 and 3 story SPC D and all SPC E structures. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| CHAPTER 1: GENERAL PROVISIONS | | | | |
|---|---|---|---|---|
| **1994 NEHRP** | **Changes** | **1995 OTFDC** | **Changes** | **Comments** |
| 1.2 Scope | This section lists structures that are exceptions to seismic design provisions. Exceptions for one and two family dwellings that were previously dependent on Av, were revised to depend on a new coefficient Ca. | 103 Scope<br>117 Existing Structures | No changes | OTFDC only applies to detached one and two family dwellings and one family townhouses not more than three stories in height, and their accessory structures. Structures exempt from the provisions in NEHRP are one and two family dwellings with Ca<0.15 and one and two family wood dwellings not more than 2 stories with Ca>0.15 constructed in accordance with the prescribed conventional construction requirements. Therefore, the structures that are relevant to the comparison are one and two family dwellings that are not more than three stories in height with Ca>0.15 and one and two family three story wood dwellings with Ca>0.15. The conventional light frame construction provisions are also relevant to the comparison. The equivalence of these sections is not an issue since the scope of the documents is not the same. |
| 1.4.4 Seismic Perfomance Category | The seismic performance category for seismic hazard exposure group III buildings with values of Av ranging from 0.15 to 0.20g was increased from C to D to reduce the risk of collapse in essential service buildings in regions of moderate seismicity. | | Outside scope of OTFDC | OTFDC is a prescriptive document that does not require the calculation of seismic loads. Therefore, seismic performance categories are outside the scope of OTFDC and this section is not relevant to the comparison. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 1.6 Quality Assurance | Quality assurance provisions now apply to other designated seismic systems in seismic performance category D. | 113.1 Types of Inspection | No changes | OTFDC specifies that inspection shall be made but the specification is not prescriptive. The quality assurance provisions default to the local jurisdiction. Therefore, this section is not relevant to the comparison. |
| 1.6.2.7.1 Special Inspection of Structural Wood | The requirement for continuous special inspection during field gluing operations was defined to be for elements of the seismic force resisting system. | 113.1.3 Frame and Masonry Inspection | No changes | OTFDC states what inspections are commonly made, however, the structural wood inspection requirements default to the local jurisdiction. Therefore, this section is not relevant to the comparison. |
| 1.6.2.7.2 Special Inspection of Structural Wood | The requirement for periodic special inspection for nailing, bolting, anchoring, and other fastening was defined to pertain to all seismic components. | 113.1.3 Frame and Masonry Inspection | No changes | OTFDC states what inspections are commonly made, however, the structural wood inspection requirements default to the local jurisdiction. Therefore, this section is not relevant to the comparison. |
| | No equivalent provision | 108 Alternate Materials and Systems | Compliance with specific performance based provisions of BOCA National Codes, ICBO Uniform Codes or SBCCI Standard Codes may be permitted as an alternate. | NEHRP does not provide alternates to the provisions. Equivalence to a particular code should be judged on a case by case basis. |

### CHAPTER 2: STRUCTURAL DESIGN CRITERIA, ANALYSIS AND PROCEDURES

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 2.2.2 Structural Framing Systems | New building frame systems, particularly relating to composite systems, were added. R and Cd values for ordinary moment frames of reinforced concrete and intermediate moment frames of reinforced concrete were increased. | | No equivalent provision | OTFDC is a prescriptive document that does not require the calculation of seismic loads. Therefore, seismic loads are outside the scope of OTFDC and this section is not relevant to the comparison. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 2.2.5.2.1 Component Load Effects | No changes. | 301.5 Roof Load | A new table that provides roof live load is included. | The required live load in NEHRP defaults to the governing building code. Therefore, a direct comparison is not possible. |
| 2.2.6 Combination of Load Effects | Load combinations are referenced to ANSI/ASCE 7-93 which differ from the previously given combinations. In earthquake load combinations, the dead load factor is slightly higher but the live and snow load factors are typically lower. The vertical earthquake loads depend on Ca where they previously depended on Av. The new vertical loads will be less for soil profile A, equivalent for soil type B and in most cases they will be larger for soil types C, D and E. | 301.1 Design | No changes | OTFDC states that buildings and structures shall be constructed to support all loads. In OTFDC, load combinations default to the governing jurisdiction. Therefore, load combinations are outside the scope of OTFDC and this section is not relevant to the comparison. |
| 2.2.7 Deflection and Drift Limits | The category for single story buildings in the allowable drift limit table was deleted. Previously there was no limit on the allowable drift for single story buildings in seismic hazard exposure group I. New stringent allowable drift limits have been specified for masonry buildings. | | Outside scope of OTFDC | OTFDC is a prescriptive document that does not require the calculation of deflection and drift. Therefore, allowable drift is outside the scope of OTFDC and this section is not relevant to the comparison. |
| 2.3.2 Seismic Base Shear | The statement regarding the amount of snow load to include in the dead load weight was deleted. | | Outside scope of OTFDC | OTFDC is a prescriptive document that does not require the calculation of seismic loads. Therefore, seismic base shear is outside the scope of OTFDC and this section is not relevant to the comparison. |
| | No equivalent provision | 301.2 Climatic and Geographic Design Criteria | Radon resistant construction is a new consideration. | Radon resistant construction is not a consideration in NEHRP. However, this is not related to the seismic safety of a building. Therefore, the sections may be judged equivalent. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

### CHAPTER 3: ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 3.1.3 Seismic Forces | Previously, lateral force calculations for architectural and mechanical/electrical equipment were separated. In the new provisions, general formulas for all equipment are provided. The formulas depend on Ca, importance factor of the equipment, component amplification, response factors, and vertical location of the equipment in the building. | | Outside scope of OTFDC | OTFDC is a prescriptive document that requires little calculation. Therefore, the calculation of seismic forces is outside the scope of OTFDC and this section is not relevant to the comparison. |

### CHAPTER 4: FOUNDATION DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 4.1 General | No changes | 401.1 Applications | The wood foundation provisions only apply to buildings not more than two floors and a roof and as long as no dimension in a basement room or crawl space exceeds the smaller of either the building width or length. | Since NEHRP does not specifically disallow certain foundations for certain buildings, OTFDC is more stringent. Thus, the sections are equivalent. |
| 4.2.2 Soil Capacity | No changes | 401.4.1 Geotechnical Evaluation | In lieu of a complete geotechnical evaluation, load bearing values for various types of soil are given. | NEHRP states that the capacity of the soil shall be sufficient to support the structure, however, no capacity values are prescribed. Therefore, the sections may be judged essentially equivalent. |
| 4.2.1 Structural Materials | No changes | 402 Materials | Material requirements for foundation materials such as wood, fasteners and concrete are included. | The material requirements in NEHRP default to the materials chapters. OTFDC contains requirements that are not included in NEHRP, such as the minimum required compressive strength. Therefore, the sections are equivalent. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| | No equivalent provision | 403.1 General | The minimum sizes for concrete or masonry footings were revised. | Both NEHRP and OTFDC reference ACI 318 for concrete and ACI 530 for masonry. Since NEHRP does not have any additional provisions beyond that, the sections are equivalent. |
| | No equivalent provision | 403.2 Footings for Wood Foundations | This new section contains requirements for wood foundations, fill material, and dimensional requirements for wood foundations. | Since NEHRP does not have an equivalent provision, the sections are equivalent. |

### CHAPTER 5: STEEL STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 5.1 Reference Documents | *Seismic Provisions for Structural Steel Buildings* by AISC was added as a reference, and as a result, the length of this chapter was reduced. Part I is based on AISC *LRFD* and Part II is based on AISC *ASD*. Updated versions of *LRFD* by AISC and *Standard Specification, Load Tables and weight Tables for Steel Joists and Joist Girders* are referenced. Another new reference is *Load and Resistance Factor Design Specification for Cold-formed Stainless Steel Structural Members*. | | Outside scope of OTFDC | Steel structure design is outside the scope of OTFDC. Therefore, this section is not relevant to the comparison. |
| | No equivalent provision | 804 Metal | The type of material that metal structural elements in roof-ceiling construction should be made of was deleted. The design references were deleted. | Since NEHRP does not have an equivalent provision, the sections are equivalent. |

### CHAPTER 6: CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 6.1 Reference Documents | The revised version of ACI 318-89 is used as a reference. The revised version includes Building Code Requirements for Structural Plain Concrete. | 404.1 Concrete and Masonry Foundation Walls | For the construction of foundation walls, ACI 318-89 and ACI 318.1-89 are referenced. | Since the references are the same, the sections are equivalent. |
| 6.6.3 Plain Concrete | New requirements for plain concrete footings, walls in the basement, foundation, or other walls below the base with seismic performance category C were added. | 404.1 Concrete and Masonry Foundation Walls | ACI 318.1 is referenced for concrete and masonry foundation walls provisions. | NEHRP also references ACI 318.1. NEHRP contains other requirements, however, one and two family dwellings three stories or less in height are exempted. Requirements for the nominal thickness and maximum depth of unbalanced fill are given in OTFDC that are not in NEHRP. Therefore, the sections are equivalent. |
| | No equivalent provision | 505 Concrete Floors (on Ground) | The control joint requirements were deleted. | Since NEHRP does not have provisions relating to control joints, the sections are equivalent. |

### CHAPTER 7: COMPOSITE STEEL AND CONCRETE STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| Chapter 7 Composite Steel and Concrete Structure Design Requirements | This new chapter presents design and detailing requirements for composite structures that are expected to provide structural toughness, ductility, strength, and stiffness equivalent to comparable concrete and steel structures. | | Outside scope of OTFDC | Composite steel and concrete structure design is outside the scope of OTFDC. Therefore, this section is not relevant to the comparison. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

### CHAPTER 8: MASONRY STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 8.1 General | The masonry structure design approach was changed from working stress design to limit states design. | | Outside scope of OTFDC | OTFDC is a prescriptive document that requires little calculation. Therefore, masonry design approach is outside the scope of OTFDC and this section is not relevant to the comparison. |
| 8.1.2 Reference Documents | Thirty-five material standard references were added. | 604.1 General | This new section states that masonry construction shall be in accordance with ACI 530/ASCE 5/TMS 402-91 or the provisions in the section. | The main design provisions are equivalent in the documents. Although OTFDC does not reference all of the material standards in NEHRP, the sections are judged equivalent since material standards are not critical to life safety. |
| 8.3.9 Seismic Perfomance Category E<br>8A.8.1 Construction Requirements | The requirement for solid grouting of structural masonry that is not part of the seismic resisting system was removed. | 607 Grouted Masonry | No changes | OTFDC does not require solid grouting of structural masonry. Therefore, the sections are equivalent. |
| 8.6.3 Design of Plain Unreinforced Masonry Members | The allowable flexural compressive stress for unreinforced masonry in non-seismic applications is now proportional to the strain up to 0.85f'm. The previous version limited this condition to 0.33f'm. | 604.4 Allowable Stresses | No changes | OTFDC prescribes allowable axial compressive stresses but does not address flexural compressive stresses. Therefore, since this is outside the scope of OTFDC, this section is not relevant to the comparison. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 8.11.3 Flanged Shear Walls | A requirement was added that states that solid units shall be laid in running bond and 50% of the masonry units at wall intersections shall be interlocked. The effective width of flange in compression was changed from 1/6 of the wall height to 9 times the thickness of the web. The effective width of flange in tension was changed from 1/3 of the wall height to 3/4 of the wall height. | 604.8.1.1 Bonding Pattern | No changes | OTFDC also requires that 50% of the masonry units at wall intersections be interlocked. Therefore, the sections are equivalent in this respect. The effective flange width is outside the scope of OTFDC since OTFDC is a prescriptive document that requires little calculation. Therefore, this aspect of the section is not relevant to the comparison. |

### CHAPTER 9: WOOD STRUCTURE DESIGN REQUIREMENTS

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 9.1 Reference Documents | Several reference documents have new editions and there are a few new references. | 4702 Referenced Standards | Some changes | Many of the reference standards are the same. Therefore, the sections are equivalent. |
| 9.2 Strength of Members and Connections | The factor to multiply the allowable working stress has been increased from 2.0 to 2.16. The phi factors have been revised. The phi factor was reduced for members in flexure with compression. The categories of connectors have been revised. The phi factor was reduced for shear on diaphragms and shear walls. In general, with the increase in capacity and decrease in phi factor, the resulting nominal capacity is lower. | | Outside scope of OTFDC | OTFDC is a prescriptive document that requires little calculation. Therefore, strength of members and connections is outside the scope of OTFDC and this section is not relevant to the comparison. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| 9.9.1.2 Shear Panels Sheathed with Other Sheet Materials | Previously, light framed walls sheathed with lath and plaster, gypsum sheathing boards, gypsum wallboard, or fiberboard sheets could be used to resist earthquake forces. Except in conventional construction, new provisions do not allow sheet materials other than structural-use materials to be part of the seismic force resisting system. | Chp 7 Wall Coverings | No major changes | OTFDC is a prescriptive document that does not require calculations relating to seismic force resisting systems. OTFDC and NEHRP both allow the use of various types of sheathing on light framed walls. Therefore, the sections are equivalent. |
| | NEHRP references OTFDC for wood provisions | 502.3 Allowable Spans | Values in table 502.3.1c (Design Values for Dimensional Lumber) have been revised and the species of wood have also been changed. | Since NEHRP references OTFDC, the sections are equivalent. |
| | NEHRP references OTFDC for wood provisions. | 503.1 Lumber Sheathing | The maximum allowable spans for lumber used as floor sheathing was increased. The basis for the increase is using higher strength lumber. | Since NEHRP references OTFDC, the sections are equivalent. |
| | NEHRP references OTFDC for wood provisions. | 602.3 Exterior Walls | Table 602.3a (Fastener Schedule for Structural Members) has been revised. In general, the revisions require smaller nails. Table 602.3b (Allowable Stud Spacing for Wood Structural Panel Wall Sheathing) has been revised. The revision requires a closer stud spacing for some of the thinner wall panels and will allow for a larger stud spacing for some of the thicker wall panels. Table 602.3c (Allowable Spans for Particleboard Wall Sheathing) has been revised. The allowable spans for 5/16, 3/8, 7/16 thickness were deleted. | Since NEHRP references OTFDC, the sections are equivalent. |

## Table 5B: Changed Provisions in OTFDC and NEHRP Judged Equivalent or Not Relevant

| 1994 NEHRP | Changes | 1995 OTFDC | Changes | Comments |
|---|---|---|---|---|
| | NEHRP references OTFDC for wood provisions. | 602.6.2 Plywood Box Headers | Previously the design was referenced and now the requirements are located in the document. | Since NEHRP references OTFDC, the sections are equivalent. |
| | NEHRP references OTFDC for wood provisions. | 802.4.1 Purlins | This new section states that purlins may be installed to reduce the span of the rafters. | Since NEHRP references OTFDC, the sections are equivalent. |
| | NEHRP references OTFDC for wood provisions. | 802.11 Roof Tie-Down | The wind uplift forces on roof trusses and rafters were increased. Previously ASCE 7 was an acceptable alternate for determining loads, but it is no longer referenced. | Since NEHRP references OTFDC, the sections are equivalent. |
| | NEHRP references OTFDC for wood provisions. | 803.1 Lumber Sheathing | This new section provides the minimum required thickness for lumber sheathing. | Since NEHRP references OTFDC, the sections are equivalent. |
| | NEHRP references OTFDC for wood provisions. | 803.3.3 Installation | Requirements for particleboard roof sheathing subjected to wind pressures of 30 psf or greater are given. | Since NEHRP references OTFDC, the sections are equivalent. |